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MASTER

FINAL REPORT
PEREGRINE FALCON STUDY

FEBRUARY 1, 1980

Prepared Under Grant From
U.S. Department of Energy
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Geothermal Research, Information and Planning Services / A California Joint Powers Agency

Lake County
Mendocino County

Napa County
Sonoma County

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INTRODUCTION TO PROJECT REPORTS

The field studies on Peregrine Falcon foraging activities described herein were initiated to determine the possible impact of geothermal development on this endangered species. In 1977, Republic Geothermal, Inc. commissioned a field study by Monte N. Kirven, Sonoma State University, to provide information on the Peregrine Falcon eyrie which was located in close proximity to a proposed exploratory well site.

The information obtained in this field study (see I, Appendix A) was not considered sufficient for decision making by the Sonoma County Planning Department. Since the falcon eyrie is adjacent to the boundary between Lake and Sonoma Counties, and is close to Napa County, the Sonoma County Planning Department Staff felt that information generated in further study would be of interest and concern to the other counties. Tom Cordill, Sonoma County Planning Department, approached the G.R.I.P.S. Commission with a proposal that G.R.I.P.S. seek a grant from the Department of Energy to conduct a more detailed study of the foraging activities of the falcon and the potential impact of geothermal development on those activities.

In May, 1978, Mr. Cordill took the responsibility for developing the proposal and submitting it to the Regional Office of the Department of Energy. The grant of \$32,500 was approved in May, 1978, and organization of the project was initiated immediately thereafter.

Mr. Cordill brought together the Advisory Committee listed on Page ii. The group developed the program plan which called for:

visual observation during the summer of 1978; the Phase I Report of that activity; the outline for the 1979 telemetry study; and, the projected schedule for all of these activities.

An abstract of the Phase I Field Study Report is provided on Page I-ii. The recommendations from that Study are included on Page I-48. The Phase I Report was presented by Dr. Kirven to the G.R.I.P.S. Commission at its November 9, 1978, Meeting. Subsequently, copies were forwarded to the Department of Energy Regional Office in San Francisco.

The Advisory Committee met in November of 1978 to review the first Draft of the Phase I Report and to develop the detailed Work Program for the telemetry study activities. As a follow-up to the decisions made at this meeting, the G.R.I.P.S. Commission made an agreement with the U.S. Bureau of Land Management for Richard R. Olendorff, BLM Sacramento staff member, to coordinate the Phase II Telemetry study activities. In addition to the time devoted by Mr. Olendorff and his staff, the Bureau of Land Management contributed \$7,500 to the project.

The Telemetry element of the project was carried out during the spring and summer of 1979 through a contract executed between the Bureau of Land Management and James H. Enderson, Colorado College. The abstract for the final report on that part of the project is provided on Page II-ii herein. The Management Recommendations for that report are incorporated on Page II-16 herein.

The Draft Final Report on the Telemetry Phase was distributed among the members of the Advisory Committee and other review sources in November, 1979. The Advisory Committee met for a final presentation on the report on January 17, 1980. On that date, Dr. Enderson made a presentation to the G.R.I.P.S. Commission at its regular meeting.

In response to a request from the G.R.I.P.S. Commission at that Meeting, Dr. Enderson's contract with the Bureau of Land Management has been amended to provide for preparation of a semi-popular media account which is due for completion by June 1, 1980.

PHASE I FIELD STUDY:
PEREGRINE FALCONS OF MOUNT SAINT HELENA
in the
GEYSERS-CALISTOGA KNOWN GEOTHERMAL RESOURCE AREA

U. S. Department of Energy Grant No. ET-78-G-03-2068

Submitted to

GEOTHERMAL RESOURCE IMPACT PROJECT STUDY
JOINT POWERS AGENCY
and
U. S. DEPARTMENT OF ENERGY
and
OTHER INTERESTED PARTIES

by

Monte N. Kirven

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ABSTRACT

The Phase I field study was conducted from 30 May to 20 August 1978 in an effort to monitor the foraging and breeding activities of a family of endangered American Peregrine Falcons nesting in the vicinity of Mt. St. Helena, Sonoma County, California to determine, if possible, the extent to which these birds utilize the adjacent Known Geothermal Resource Area. Prominent local terrain features and forest vegetation hampered visual tracking of the falcons throughout the durations of their foraging flights and 59.6 percent of all observed flights and 93.3 percent of all successful flights were lost from view of the observers at the terminal extensions. In spite of this inherent difficulty 65 map plots were recorded for foraging flights within a 3.3 kilometer radius of the nesting site and two major flight corridors were identified along which 68 percent of all flights were oriented. The mean duration of successful flights of the adult male was 68.3 minutes, which was substantially shorter than observed for peregrines nesting at the nearby Palisades eyrie in Napa County suggesting the possible superiority of the Mt. St. Helena foraging habitat. From prey remains found in the vicinity of the nesting site thirteen species were identified. Pigeons and doves comprised 67.3 percent of the total biomass, compared to 69.4 percent at the Palisades eyrie in 1975, stressing the importance of these birds as prey items. A total of 32 territorial defense flights were observed at the Mt. St. Helena site in 1978 and Golden Eagles appeared to elicit the most aggressive responses from the falcons with a mean attack distance of 767 meters and a maximum of 2 kilometers observed. Red-tailed Hawks were second in importance with a mean distance of 330 meters, and Turkey Vultures were relatively unimportant. Hunt observed similar behavior for the Palisades Peregrines in 1976. Human intruders at both sites caused the breeding peregrines to become highly agitated and for this reason strict protection of these sites is essential. Three young fledged at Mt. St. Helena in 1978 with a mean fledging success rate of 2.8 observed for 5 years which represents high success when compared to Peregrines in other regions of North America. The post-fledging parental care period lasted for at least two months and a yearling from 1977 appeared at the eyrie several times during the 1978 breeding season. Floral and faunal diversity in the study area was noteworthy with 218 species of plants, 77 species of birds, 38 species of mammals, 14 species of reptiles and 11 species of amphibians inventoried for at least seven biotic communities represented. Such diversity provides a prey base which insures the continued reproductive success of the falcons. Human alteration of the habitat could threaten the long-term survival of this endangered species as it has in Southern California where breeding Peregrines are now almost extinct. The foraging range and fate of fledglings at Mt. St. Helena could not be determined during 1977 and 1978 in the absence of telemetry data. Therefore, the author emphatically recommends that such data be gathered during the 1979 breeding season and every effort be made to expedite the Phase II field study.

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INTRODUCTION

Historical Retrospect

Peregrine Falcons have been known to nest in the immediate vicinity of Mount Saint Helena from 1970 through 1973 (Wenzel and Gheen 1975), and probably during the preceeding years in the characteristic manner of the species (Harlow, personal communications). The area was unoccupied by breeding birds from 1974 through 1976, and it was feared that the tragic pattern of reproductive failure, which has been well-documented throughout most of the species range in North America (see Appendix), was being repeated at this site. In 1977, however, a pair of breeding Peregrines appeared late in the season and fledged three young. Because the site is located in close proximity to proposed geothermal exploratory drilling sites much local interest was aroused. Concern was expressed about the potential threat of such development to the long-term survival of these endangered falcons by members of the California Department of Fish and Game, U. S. Department of Interior Fish and Wildlife Service and Bureau of Land Management, Sonoma County Planning Department, California State Parks, faculty of Sonoma State University and other local colleges, and ornithological and conservation groups, as well as concerned citizenry. During the same year, in response to these concerns, Republic Geothermal, Incorporated assumed the financial responsibility of contracting the author to initiate a study to monitor the foraging and breeding activities of the falcons in an attempt to assess the potential impact of drilling operations which Republic was planning to undertake in the Briggs Creek drainage of their leasehold on the McMicking Ranch, which includes the descending foothills west of the Peregrine nesting site.

The results of the 1977 field study were deemed inconclusive by the

author, but much useful information was gathered and a copy of the report

submitted to Republic Geothermal, Inc. and other interested parties has

been included in the Appendix to be used as a companion document. The

author recommended that a more thorough study employing radio-telemetric,

as well as visual monitoring techniques be undertaken as soon as possible.

In subsequent meetings of representatives from the U.S. Fish and Wildlife

Service, Bureau of Land Management, California Department of Fish and Game,

Sonoma County Planning Department, Republic Geothermal, Inc. and the ac-

ademic community, it was unanimously concluded that such a study be pursued

with vigor. A committee of experts on falcon biology and radio-telemetry

was appointed for further discussions and proposals.

Early in 1978 a research proposal was submitted by the Sonoma County

Planning Department through the G.R.I.P.S. Joint Powers Agency to the U.S.

Department of Energy, which awarded Grant No. ET-78-G-03-2068 in support

of the proposed research on May 8, 1978. The Phase I field study was

commenced at the end of May under the direction of the author and the

findings comprise this report.

Objectives

The Phase I field study was undertaken to conduct visual tracking of

the pair of adult Peregrine Falcons nesting at Mt. St. Helena and record

direction, distance, frequency, and duration of flight patterns which

might be in, over or through contiguous geothermal areas; to collect and

analyze prey remains around the nesting site and inventory adjacent hab-

itats occupied by potential prey species.

METHODS AND THE STUDY AREA

The Study Area

In 1978 the falcons nested in precisely the same location as they did during the previous year, therefore the description of the major topographic and vegetative features of the area in the immediate vicinity of the eyrie included in the 1977 report remains applicable (see Appendix). In addition to those general remarks, the biotic diversity of the foraging area of the falcons was considered by the author to be sufficiently noteworthy to warrant more thorough investigation during the 1978 Phase I field study. A botanical inventory, conducted in the watershed to 5.5 kilometers south of the eyrie cliff, reflected the rich diversity of the area. The plant communities represented within the study area include Douglas-fir Forest, Mixed Evergreen Forest, Oak Woodland, Riparian Woodland, Chaparral, Grassland and Freshwater Marsh. A list of 218 plant species was compiled by Craig Thomsen for the study area (see Results and Discussion). It was anticipated that such an extensive and diverse vegetation complex and species rich flora would support a large and abundant avifauna which would constitute a potential prey base for the Peregrines. A bird census was conducted in the same watershed and over the ridge running southwest from the eyrie cliff and along the western side of the canyon to a distance of 1.7 kilometers. Seventy-seven bird species were observed in the study area by Bryant Bainbridge and other members of the observation team (see Results and Discussion). Additional faunal lists of mammals, reptiles and amphibians were compiled by the author and included in this report to further demonstrate the biotic diversity of the study area (see Results and Discussion).

The Observation Program

The Phase I field work commenced on 30 May 1978 and terminated on

20 August of the same year. During the period of 30 May to 13 July, day-long observations were made on the activities and directional movements of the falcons from two vantage points in the vicinity of the eyrie. These sites, which will be referred to as Observation Posts (OP 1 and 2), were located southeast of the eyrie at distances of 350 meters (OP1) and 760 meters (OP2). The elevation of OP1 was just below the level of the nesting ledge and OP2 was just above it. The observation team consisted of Timothy Bowles, Steven Hoddy, Bryant Bainbridge, Douglas Boyce and Craig Thomsen. Bowles and Hoddy, who were most familiar with the site, conducted the majority of the observations during the field study, and were relieved at intervals by the other members of the team. Prior to the initiation of the Phase I field observation program, surveillance personnel representing the U.S. Department of Interior, Fish and Wildlife Service, Pacific Coast Peregrine Falcon Recovery Team Program were on 24-hour duty at OP2 from just prior to egg-laying (7 March) until 1 June. Thomas Scott was responsible for surveillance during weekdays and on weekends he was relieved by State Park Ranger William Grummer. They also recorded their observations on the falcons and some of their data has been included in this report. Observational data from other surveillance personnel (Wenzel and Gheen 1975, Hunt 1976) at another Peregrine Falcon eyrie located 3 kilometers to the southeast have also been incorporated into this report for comparative purposes. On 19 July the author, members of the observation team, and Denzil Verardo from the Sothe-Napa Valley State Park visited the study area to collect prey remains from the eyrie cliff. Hoddy rappelled to the nesting ledge and Verardo provided the belay aid, while the remainder of the party searched the rim and base of the cliff for prey items. Subsequent visits were made to the top of the cliff on 26 July and 20 August.

by the author to determine the duration of occupancy of the site by the falcons.

With the exception of the following, the observational techniques and equipment were the same as those employed in 1977 and will not be repeated here (see Appendix). Efforts to plot triangulations on the map were abandoned because it was almost impossible for observers at the two observation posts to simultaneously plot the location of a falcon at the terminal extension of the flight path due to visual obstacles in the mountainous landscape. Instead, compass bearings and flight directions were recorded by one observer who would consult the other observer on the radio when necessary. By familiarizing themselves with prominent local terrain features, the observers were able to estimate approximate distances of the falcons along the compass bearings and flight direction.

The observed activities and movements of the falcons were subdivided by the author from the field notes into the following categories:

1. Breeding behavior, including courtship, copulation, clutch formation, incubation and all other behavior associated with the chronological events of the reproductive cycle. From these data the timing of the reproductive chronology was extrapolated (Table 8).
2. Foraging flights, including departure times and directions, maximum observed distances (Figure 1), times and directions of return flights, success or failure in obtaining prey, and food exchanges at or near the eyrie (Table 1).
3. Territorial defense attacks on intruders in the vicinity of the eyrie, including the species involved and descriptions of the flights (Table 7).
4. Flights which did not appear to result in any of the above categories such as movements from perch to perch, soaring without departure, apparent exercise and play. These data were irrelevant to the objectives of the study, and were omitted from this report.

Identification of Prey Species

The remains of prey items collected on 19 July were taken to the Ornithological collection of the California Academy of Sciences in San Francisco for comparison with intact study skins and skeletons. Species identification was accomplished for all but a single item by the author and Bryant Bainbridge.

RESULTS AND DISCUSSION

Foraging flights

The mountainous terrain and forest vegetation in the study area hampered visual tracking of foraging flights again in 1978. However, it was possible to monitor the movements of the falcons to some extent and 65 map plots were recorded for visual sightings (Figure 1). Each plot represents the position of the falcon at the terminal extent of the flight or the point at which it was last seen by the observer. The sex of the falcon and the approximate direction of the flight path were also recorded for each observed foraging flight. Numerical designations for the plots represent the chronological occurrence of sightings and can be cross-referenced to additional information in Table 1. From these data it can be seen that in the majority of cases the terminal extensions of the foraging flights were lost from the view of the observers. This occurred when the falcons flew behind prominent terrain features, blended with the forest background or passed beyond the limit of visibility for the 20x spotting scopes. Of all the flights observed 56.9 percent were lost from view (Table 1) and 93.3 percent of successful flights were also lost (Table 2). The higher proportion of lost flights in the latter category suggests that successful foraging flights extended to greater distances on the average than unsuccessful forays. Only the foraging flights of the adult male were considered in this study, in terms of success, because of the traditional role of males of this species to provide most of the food during the breeding cycle, and the possibility that the female received prey in a food exchange out of view of the observers before returning from a flight. The mean duration of successful foraging flights was observed to be 68.3 minutes (Table 2) compared to a mean of 27.3 minutes ($n = 9$) for unsuccessful flights. This

Figure 1 Map Plots of Observed Peregrine Falcon Foraging Flights in 1978.

Table 1. Foraging Flights of Adult Peregrine Falcons at Mt. St. Helena in 1978.

Map Plot Number	Date	Sex	Time Out	Time In	Observed Flight Path	Compass Bearing	OP#
1	5/30	M	1400 hrs		Lost heading E from eyrie	9°	1
2	"	"	1615	1710	Lost heading NW from eyrie	334°	2
3	"	"	1710	1724	Lost E of Landmark (LM) A	141°	2
4	"	"	1746	--	Pursuing prey toward LM A	132°	2
5	5/31	"	1012	1117	Lost heading E from above OP1	60°	2
6	"	"	1620	--	Lost heading W from eyrie	288°	2
7	6/3	"	1530	--	Lost heading W from eyrie	290°	2
8	6/4	F	1457	1504	Stooped at pigeon heading S from LM C	215°	1
9	"	M	1600	--	Lost diving SW from LM C	251°	2
10	"	F	1612	--	Lost flying high E of LM A	144°	2
11	6/5	M	1201	1202	Stooped at swift NE of eyrie	358°	1
12	"	"	1231	1240	Toward LM C from eyrie	248°	1
13	"	M	1430	1630	From LM C to LM A	248°	1
14	"	F	1510	1515	S from eyrie, accelerated to LM A	194°	1
15	6/6	"	1240	1530	Lost heading S from above LM B	240°	1
16	"	M	1310	1605	SW from eyrie, lost heading W	238°	1
17	"	F	1530	1605	Stooped at prey near LM C heading S	268°	2
18	"	?	1612	1630	Toward LM A from S of eyrie	215°	2
19	"	F	1630	--	SW from LM C, returned to eyrie	255°	1
20	6/7	F	1645	--	Stooped SE from high above LM C	245°	2

Table 1 -- Continued/

Map Plot				Time	Time		Compass		
Number	Date	Sex	Out	In	Observed Flight Path	Bearing	OP#		
21	6/8	F	0905	1030	Long dive to E of LM A from E of OP2	145°	2		
22	"	M	1030	1141	Lost heading E from above OP1	80°	2		
23	"	"	1150	--	Lost heading SW from above LM B	235°	1		
24	6/9	F	0725	0748	Heading W from eyrie	284°	1		
25	"	"	0807	0825	Stooped near LM E	13°	2		
26	"	"	1054	1215	Lost heading E from OP 1	69°	2		
27	"	M	1440	--	Lost heading W from above LM C	261°	1		
28	"	F	1451	--	Lost heading SW from eyrie	225°	1		
29	"	"	1825	1855	Lost heading SE from OP2	138°	1		
30	"	"	1918	--	Rapid pursuit to SSE from eyrie	170°	1		
31	6/13	M	1120	1209	Soaring toward LM B from above eyrie	316°	1		
32	"	"	1410	--	Stooped at prey near LM C	309°	1		
33	6/14	"	1110	--	Lost heading E from eyrie	351°	2		
34	6/15	"	1130	--	Dove past LM B from near LM C heading SW	231°	1		
35	"	"	1553	1702	Lost heading NW over eyrie cliff	310°	1		
36	"	"	1730	--	Lost heading NW over eyrie cliff	335°	1		
37	6/16	F	1310	1507	Lost heading SW from eyrie	235°	1		
38	"	"	1820	--	Lost heading SE from near eyrie	162°	1		

Table 1 -- Continued/

Map Plot Number	Date	Sex	Time Out	Time In	Observed Flight Path	Compass Bearing	OP#
39	6/17	F	0940	1055	Lost in rapid pursuit heading E from eyrie	78°	1
40	"	M	1600	1615	Pursued swift and continued heading SE	165°	1
41	6/18	?	1610	--	Heading from OP1	180°	1
42	"	M	1640	--	Lost heading N over eyrie cliff	315°	1
43	"	"	1755	--	Lost soaring toward NW from above eyrie cliff	316°	1
44	6/20	"	1020	1045	Long stoop at prey from NW of LM E	355°	2
45	"	F	1120	1130	Stooped at prey ESE from OP2	105°	2
46	"	M	1355	--	Lost soaring SW from LM C	277°	1
47	6/21	"	1100	1131	Stooped at prey heading SW from LM B	243°	2
48	"	F	1255	--	Heading S in rapid pursuit from above OP1	184°	1
49	"	M	1710	1800	Lost in stoop near LM C	251°	1
50	6/22	F	0912	0920	Stooped E of eyrie and contin- ued heading E	8°	1
51	6/24	M	1535	1737	Lost heading E from eyrie at high speed	82°	1
52	"	"	1535	1737	Lost heading E from eyrie at high speed	82°	1
53	6/25	"	0846	0855	Lost heading NE from eyrie at high speed	26°	1
54	6/26	"	0815	0920	Lost heading S between LM A and LM B	210°	1
55	"	"	1028	--	Heading to LM D from above OP1	349°	1

Table 1 -- Continued/

Map Plot Number	Date	Sex	Time Out	Time In	Observed Flight Path	Compass Bearing	CP#
56	6/26	F	1215	1320	Lost heading E from LM D	351°	1
57	"	"	1545	--	Lost soaring E from above eyrie	5°	1
58	6/29	M	1805	--	Lost heading SW from LM B	248°	1
59	6/30	"	1120	1201	Lost heading SW from LM B	241°	1
60	"	"	1209	--	Lost heading SW after stooping at B-T Pigeon near LM C	238°	1
61	7/1	F	1315	--	Gliding high over LM D	20°	1
62	"	M	1517	1610	Stoop at R-T Hawk near LM C and continued heading SW	237°	1
63	"	"	1632	1643	Lost in stoop from high above LM C	245°	1
64	7/2	"	1525	1546	Lost in stoop from high above OPI	254°	1
65	7/10	"	1338	1411	Lost heading SSW between LM A and LM B	218°	1

Table 2 Successful Foraging Flights of the Adult Male Peregrine Falcon at the Mount Saint Helena Eyrie in 1978.

Date	Time Out	Time In	Total Time (min)	Observed Departure Flight Path	Observed Return Flight Path	Food Exchange Observed
5/8	0859	0944	45	Lost heading SE from OP2	From SW of OP2	+
"	1645	1950	185	Lost heading SW from LM C	From NE of OP2	+
5/9	0802	0847	45	Lost heading NE from	From NE of OP2	+
5/13	0902	1007	65	Lost heading W near LM C	At eyrie, direction unknown	+
5/16	0629	0728	59	Lost heading SW from LM C	From NE of OP2	+
"	1436	1528	52	Lost heading E from eyrie	From E of eyrie	+
5/20	1130	1227	57	Lost heading NE from eyrie	At eyrie, direction unknown	+
5/22	1249	1326	37	Lost heading SW from LM B	At eyrie, direction unknown	+
"	1610	1948	218	Lost heading W from LM C	From NE of OP2	+
5/23	1102	1209	67	Lost heading NE from OP2	From SE of OP2	+
5/24	1617	1710	53	Lost heading SW from eyrie	From S ?	+
5/27	0724	0822	58	Lost heading E from eyrie	From E of eyrie	+
5/28	1055	1152	57	Lost heading E from LM D	From NE of OP2	+
5/29	1637	1741	64	Lost heading SE from OP2	From SE of OP2	+
5/31	1012	1117	65	Lost heading E from eyrie	From E of OP2	+

Table 2 -- Continued/

		Time	Time	Total	Observed Departure	Observed Return	Food	
	Date	Out	In	Time (min)	Flight Path	Flight Path	Exchange Observed	
	6/5	1201	1231	30	Lost heading N from eyrie	From N of eyrie	+	
	"	1430	1630	120	From LM C to LM A	From SE (LM A) of OP1	+	
	6/6	1310	1605	175	Lost heading W from SW of LM B	From W of eyrie	+	
	6/8	1028	1030	2	Stooped at prey SE of OP2	From SE of eyrie	+	
	"	1030	1140	70	Lost heading E from eyrie	At eyrie, direction unknown	0	
	6/13	1120	1209	41	Lost heading SW from eyrie	At eyrie, direction unknown	+	
	6/15	1553	1702	69	Lost heading NW over eyrie cliff	From SW of OP2	+	
	6/20	1020	1045	25	Lost heading E from LM D	From E of eyrie	0	
	6/21	1100	1131	31	Lost in stoop W from LM C	From W of eyrie	0	
	"	1710	1800	90	Lost in stoop SSW of LM C	At eyrie, direction unknown	+	
	6/24	1535	1737	122	Lost heading NE from eyrie	At eyrie, direction unknown	0	
	6/30	1120	1201	41	Lost heading SW of LM B	From W of eyrie	0	
	7/1	1517	1610	53	Lost in stoop SW of LM B	At eyrie, direction unknown	-	
	7/2	1525	1546	21	Lost in stoop heading W of OP1	At eyrie, direction unknown	+	
	7/10	1338	1471	33	Lost heading SSW from LM C	From LM A	0	

+ = w/ad. ♀
0 = w/young

observation tends to support the conclusion that successful foraging flights covered greater distances than unsuccessful foraging flights. The slightly longer mean duration of foraging flights (77.3 minutes) of the adult male in 1977 (Table 3) could be the result of a greater familiarity with the area, if it can be assumed that he arrived on the scene after the period of inactivity of the nesting site. However, other factors such as differential availability and abundance of prey during the two breeding seasons must also be considered. When compared to the mean foraging flight duration of the male Peregrine at the nearby Palisades eyrie (Table 3) it can be seen that the Mt. St. Helena male apparently required less time to obtain food. Hunt (1976) has suggested that duration of foraging flights can be used as an index of habitat quality. If this is a valid assumption, then the foraging habitat utilized by the Mt. St. Helena falcons must be considered to be superior. The comparatively shorter mean duration of foraging flights observed by White (1974) in Alaska could be due to the fact that the tundra habitat is relatively devoid of cover for evasive maneuvers of prey species.

The exact size of the foraging area cannot be determined from the data now available because most of the foraging flights were not observed throughout their durations. The majority of flights (87.7 percent), however, were tracked to within 2 kilometers of the eyrie and the remainder (12.3 percent) were between 2 and 3.3 kilometers. From these plots it can be seen that two main flight corridors were used in 1978 which followed certain terrain features (Figure 1). Perhaps the most important corridor consisted of the watershed canyon which fans out from near the base of the eyrie cliff and descends to the southwest with ridges running southwest and south-southeast. The canyon lies between landmark C and Observation Post 2 at

Table 3 Comparative Durations of Foraging Flights for Adult Male Peregrine Falcons During the Breeding Season.

Authority	Year	Mean Flight Time (min)	Range (min)	n	Location of Eyrie
Wenzel and Gheen	1975	106	18-290	26	Palisades, Napa County, California
Hunt	1976	81.5	8-167	53	Palisades, Napa County, California
Kirven	1977	77.3	3-169	37	Mt. St. Helena, Sonoma Cty., Calif.
Kirven	1978	68.3	2-218	29	Mt. St. Helena, Sonoma Cty., Calif.
White	1974	57	22- 93		Franklin Bluff, Sagavanirktok River, Alaska

the upper extremity, and between landmarks B and A further down slope. The falcons frequently followed the ridgeline between landmarks C and B and oriented their departure flights in a southwest direction, or flew southward over the canyon from various locations in the vicinity of the eyrie. This is a natural pathway because it takes advantage of the lift provided by the prevailing winds coming up the slopes of the canyon, and the canyon expands out into a wide valley (Knight's Valley) with an abundance of cleared fields and open foraging habitat. Wenzel and Gheen (1975) observed the Peregrines, which formerly nested at Mt. St. Helena, foraging as far as 4.85 kilometers in the same direction, and it is probable that the foraging range includes much of Knight's Valley. Many other flights were observed to be oriented eastward to southeastward from the eyrie over the ridge extending from Observation Post 1 to landmark A. The eastern slope drops off abruptly and another valley lies to the east. Approximately 68 percent of all observed foraging flights were seen to be oriented in the directions mentioned above (Table 4).

Prey

The 1978 search for prey remains at and near the Mt. St. Helena eyrie, and subsequent identification of the specimens found, revealed that the number of species exploited by the falcons may have been greatly reduced from the previous year. The reduction from 22 to 13 species could signify a shift in the foraging habits of the adult peregrines through the formulation of search images for preferred prey species, and/or a greater familiarity with the foraging habitat. Wenzel, Gheen and Hunt have emphasized the relatively high importance value of Columbiform species (i.e. pigeons and doves) as a prey base at the Palisades eyrie. In 1975 Wenzel and Gheen reported that

Table 4: Directional Orientation of Foraging Flights from the
Mount Saint Helena Peregrine Falcon Eyrie in 1978.

Directional Orientation	Number of Map Plots	Percentage of Total Map Plots
N	3	4.6
NE	3	4.6
E	12	18.5
SE	8	12.3
S	11	16.9
SW	19	29.2
W	5	7.7
NW	4	6.2

the Domestic Pigeon or Rock Dove comprised 58.5 percent of the total biomass of prey brought to the eyrie and Columbiform species collectively (Rock Doves, Band-tailed Pigeons and Mourning Doves) constituted 69.4 percent of the total biomass of prey from 58 items observed. Hunt observed that 72 percent of the total biomass of prey were Rock Doves in the following year. The high proportion of Columbiform birds in the diet of breeding Peregrine Falcons was also reflected in the food remains found at the Mt. St. Helena eyrie in 1978, with 67.3 percent of the total prey biomass among 40 items (Table 5). Other species which appear to have been important, and perhaps preferentially selected by the falcons, included Acorn Woodpeckers, Scrub Jays and Starlings. Pigeons and doves were also observed to be important prey items at Mt. St. Helena in 1977 by the author and in 1975 by Wenzel and Gheen. This tendency of preferential selection of Columbiform birds by Peregrine Falcons has been well documented in other regions. If the prey base at Mt. St. Helena is broader than the 1978 data suggest, then the diversity of potential prey species in the study area should reflect its relative importance as a foraging habitat. Also, since the habitat in the study area is heterogeneous with respect to biotic communities, an evaluation of prey species diversity in each community would be relevant. The data presented in Table 6 show that avian species were most diverse in the mixed evergreen, riparian and oak woodland communities which comprise much of the natural vegetation in the Mt. St. Helena area. Agricultural lands in Franz Valley also provide habitat for such important prey species as Rock Doves and Mourning Doves (Table 6).

Territorial Defense Flights

The observers frequently witnessed aggressive aerial assaults on avian intruders by the adult peregrines in the nesting territory at Mt. St. Helena

Table 5 Prey Species of Adult Peregrine Falcons Identified from
Prey Remains at or Near the Mount Saint Helena Eyrie in
1978.

Prey Species	Number	Mean Weight (grams)	Percent Biomass
Rock Dove (<u>Columba livida</u>)	3	313*	40.8
Band-tailed Pigeon (<u>C. fasciata</u>)	3	360*	17.3
Mourning Dove (<u>Zenaidura macroura</u>)	5	115*	9.2
Common Flicker (<u>Colaptes auratus</u>)	2	137*	4.4
Acorn Woodpecker (<u>Melanerpes formicivorus</u>)	5	65*	5.2
White-throated Swift (<u>Aeronautes saxatalis</u>)	1	25*	0.4
Stellar's Jay (<u>Cyanocitta stelleri</u>)	2	38*	2.3
Scrub Jay (<u>Aphelocoma coerulescens</u>)	5	77*	6.2
Common Crow (<u>Corvus brachyrhynchos</u>)	1	420**	6.7
Starling (<u>Sturnus vulgaris</u>)	3	77**	3.7
Brewer's Blackbird (<u>Euphagus cyanocephalus</u>)	2	55	1.8
Red-winged Blackbird (<u>Agelaius phoeniceus</u>)	1	58**	0.9
Rufous-sided Towhee (<u>Pipilo erythrophthalmus</u>)	1	37*	0.6
unidentified	1	--	--
TOTALS: 13 SPECIES	40 PREY ITEMS		100 PERCENT

* Wenzel and Gheen 1975. From Ornithological Collection at University of California, Davis.

** Data obtained from Ornithological Collection at Sonoma State University.

Table 6 Bird Species Observed Within the Peregrine Falcon Foraging Habitat at Mount Saint Helena in 1978

Species	Cliffs	Chaparral	Mixed Evergreen	Riparian	Oak Woodland	Pond	Agricultural
Great Blue Heron						X	
Turkey Vulture	X	X	X	X	X	X	X
Cooper's Hawk			X	X			
Red-tailed Hawk	X	X	X		X		X
Red-shouldered Hawk		X			X		
Golden Eagle	X	X			X		
American Kestrel					X		X
California Quail		X		X	X		
Mountain Quail		X	X	X			
Band-tailed Pigeon			X		X		
Rock Dove							X
Mourning Dove					X		X
Screech Owl			X	X	X		
Great Horned Owl			X	X	X		
Pygmy Owl			X		X		

Table 6 -- Continued/

Species	Cliffs	Chaparral	Mixed Evergreen	Riparian	Oak Woodland	Pond	Agricultural
Poorwill		X					
White-throated Swift	X						
Anna's Hummingbird		X					
Rufous Hummingbird			X				
Allen's Hummingbird		X	X				
Belted Kingfisher						X	
Common Flicker			X		X		
Pileated Woodpecker			X				
Acorn Woodpecker			X		X		
Hairy Woodpecker			X				
Downy Woodpecker				X	X		
Nullall's Woodpecker					X		
Western Kingbird					X		
Ash-throated Flycatcher		X	X		X		
Black Phoebe						X	

Table 6 -- Continued/

Species	Cliffs	Chaparral	Mixed Evergreen	Riparian	Oak Woodland	Pond	Agricultural
Western Flycatcher			X	X			
Western Wood Pewee			X				
Olive-sided Flycatcher			X	X			
Violet-green Swallow			X		X		
Stellar's Jay			X				
Scrub Jay		X			X		
Common Raven	X		X		X		
Common Crow					X		X
Chestnut-backed Chickadee					X		
Plain Titmouse					X		
Bushtit		X	X		X		
White-breasted Nuthatch			X				
Red-breasted Nuthatch			X				
Pygmy Nuthatch			X				
Brown Creeper			X		X		

Table 6 -- Continued/

Species	Cliffs	Chaparral	Mixed Evergreen	Riparian	Oak Woodland	Pond	Agricultural
Wrentit		X					
House Wren					X		
Bewick's Wren		X	X		X		
Canyon Wren	X						
Mockingbird							X
California Thrasher		X		X			
American Robin			X		X		
Western Bluebird					X		
Blue-gray Gnatcatcher		X					
Starling					X		X
Hutton's Vireo			X		X		
Solitary Vireo					X		
Warbling Vireo			X	X			
Orange-crowned Warbler			X		X		
Black-throated Gray Warbler			X				

Table 6 -- Continued/

Species	Cliffs	Chaparral	Mixed Evergreen	Riparian	Oak Woodland	Pond	Agricultural
Yellow Warbler			X	X			
Townsend's Warbler					X		
McGillivray's Warbler		X					
Wilson's Warbler			X	X			
Red-winged Blackbird						X	X
Brewer's Blackbird							X
Western Tanager							X
Black-headed Grosbeak			X				
Lazuli Bunting		X			X		
Purple Finch			X		X		
House Finch					X		X
Pine Siskin					X		
Lesser Goldfinch			X		X		
Rufous-sided Towhee		X	X		X		
Brown Towhee		X			X		

Table 6-- Continued/

Species	Cliffs	Chaparral	Mixed Evergreen	Riparian	Oak Woodland	Pond	Agricultural
Lark Sparrow			X		X		
Dark-eyed Junco			X		X		
TOTAL SPECIES: <u>77</u>	6	20	40	13	43	5	12

in 1978. A total of 32 attacks were recorded for interspecific encounters with Red-tailed Hawks, Golden Eagles, Turkey Vultures, a Prairie Falcon and a Raven (Table 7). One intraspecific interaction was observed when a foreign adult male Peregrine Falcon wandered into the nesting territory and was forced out by the resident adult female (Table 7). Hunt (1976) reported that Golden Eagles elicited the most intensified territorial defense behavior in the adult falcons at the Palisades eyrie. Three such attacks were seen to extend to 550 meters from the eyrie. Similar observations were made at the Mt. St. Helena site in 1978 but the encounters were much more frequent because a pair of adult Golden Eagles nested at landmark D approximately 400 meters from the falcon eyrie. Their movements to and from their eyrie constantly provoked the Peregrines to attack. The failure of the eagles to fledge young may have been due to the constant harassment by the falcons. Vigorous attacks on Golden Eagles at Mt. St. Helena were observed at distances of up to 2 kilometers in 1978 with a mean distance of 767 meters ($n = 9$). Hunt observed that Red-tailed Hawks were pursued by the falcons to a mean distance of 330 meters from the Palisades eyrie and such attacks were much more frequent (22 recorded) probably because a pair of hawks nested in the vicinity of the falcon eyrie. Again the observations at the Mt. St. Helena eyrie yielded similar results, with a mean distance for attacks on Red-tailed Hawks of 500 meters. It should also be noted that a pair of hawks nested just south of landmark C approximately one kilometer from the Falcon eyrie.

Attacks on Turkey Vultures were frequent at both eyries because the vultures habitually soared close to the eyrie cliffs to take advantage of lift, but the falcons allowed these birds to approach to close proximity to the eyries before initiating assaults and on numerous occasions vultures passed by with impunity. The mean observed attack distances on Turkey Vultures

Table 7 Territorial Defense Flights of Adult Peregrine Falcons
at the Mount Saint Helena Eyrie in 1978.

Date	Sex of Attacker(s)	Intruder Species	Distance (meters) and Direction of Attack from Eyrie	Other Observations
4/9	M & F	Prairie Falcon	100	Attack broken off by both Peregrines at 100m
4/10	M	Red-Tailed Hawk	50	Intruder struck and forced to perch
4/16	M	Turkey Vulture	lost	Intruder chased out of sight; both falcons vocal
4/21	F	Golden Eagle	1300 NE	Falcon stooped 6 times, not vocal
4/22	M	Golden Eagle	above N to S	Intruder attacked repeatedly until out of sight
4/28	M	Turkey Vulture	15 to 40	Attack broken off at 40m from eyrie, 8 stoops
4/29	F	Red-Tailed Hawk	below	Intruder attacked and forced to perch, falcon vocal
5/2	M	Turkey Vulture	20	Intruder struck and forced to change direction
5/3	F	Golden Eagles (2)	500 E	Pair of eagles were stooped at alternately by falcon
5/4	F	Golden Eagle	above N	Intruder pursued out of sight to NNW
5/6	M	Turkey Vulture	50	Intruder approached below level of eyrie; falcon vocal
5/7	M & F	Golden Eagles (2)	500 E	Falcons attacked adult pair of eagles repeatedly
5/7	M	Golden Eagle	600 E 1000 high	Intruder forced to reverse direction
5/16	M	Red-Tailed Hawk	100 NE 50 above	Attack broken off at 200m from eyrie
5/17	M	Golden Eagle	500 NE	Intruder stooped at 5 times by falcon

Table 7 -- Continued/

Date	Sex of Attacker(s)	Intruder Species	Distance (meters) and Direction of Attack from Eyrie	Other Observations
5/17	M	Turkey Vulture	500 E	Attack broken off above OPl 350m from eyrie
5/18	M	Red-Tailed Hawk	350 SE	Intruder pursued beyond OPl reading SSE
5/24	M	Golden Eagle	500 NE	Intruder pursued out of sight
5/25	F	Raven	50	Intruder forced to change direction away from eyrie
5/27	M	Golden Eagles (2)	500 NE	Pair of eagles stooped at alternately by falcon
5/27	F	Turkey Vulture	50-100 SE	Attack broken off 100m SE of eyrie
5/27	F	Turkey Vulture	50 W	Intruder forced to change direction toward LM C
5/27	F	Turkey Vulture	E	Intruder pursued heading E out of sight; falcon vocal
5/28	M	Golden Eagle		Falcon stooped 100m at eagle and eagle evaded the attack
5/29	F	Peregrine Falcon (adult M)	SW	Intruder pursued out of area uttering fear call notes
5/30	M & F	Golden Eagle	500 NE	Both falcons attacked eagle simultaneously
5/31	M	Golden Eagle		Falcon stooped at eagle from 300m above, then eagle stooped at falcon
6/9	F	Golden Eagle	2000 S	Falcon stooped 3 times near LM A; attack broken off
6/14	M	Red-Tailed Hawk	2000 SW	Falcon attacked hawk once near LM B and continued heading SW

Table 7 -- Continued/

Date	Sex of Attacker(s)	Intruder Species	Distance (meters) and Direction of Attack from Evrie	Other Observations
6/15	M	Turkey Vulture	above	Intruder struck by falcon and pursued heading E; Falcon vocal
6/22	M & F	Red-Tailed Hawk	10	Both falcons attacked simultaneously; attack broken off near LM C
6/25	F	Red-Tailed Hawk	500 SW	Falcon stooped at intruder 2 times near LM C and continued heading W

were observed to be 58 meters ($n = 11$) at the Palisades eyrie and 98 meters ($n = 7$) at Mt. St. Helena. Other intruder species occurred only once per breeding season and were too infrequent to evaluate their relative importance quantitatively. The above mentioned observations on territorial defense behavior of the falcons during encounters with Golden Eagles, Red-tailed Hawks and Turkey Vultures are supported by similar findings in the 1977 study (see Appendix).

In the morning of 18 June 1978 a human intruder inadvertently hiked to the top of Landmark D, approximately 350 meters from the falcon eyrie and provoked the falcons into intense agitation. The adult male flew back and forth along the cliff face in front of the eyrie vocalizing loudly. He continued this behavior for five minutes until he was joined by the adult female and they proceeded to alternate these displays for 15 more minutes until the hiker descended below the ridgeline into the forest. This incident stresses the importance of preventing people from approaching Peregrine Eyries from above during the critical nesting period and the need for the continuation of the surveillance program.

From the above observations it can be concluded that the nest site defense territory at the Mt. St. Helena eyrie extends to a radius of approximately 2 kilometers and protection of this area must be considered essential to the long-term survival of the Peregrine Falcons at this site.

Breeding Cycle Chronology and Fledging Success

The onset of the breeding cycle was observed to be earlier at Mt. St. Helena in 1978 than during the preceeding year, which more closely conformed to the normal timing for the species in California (Bent 1938). The unusually late, but successful, nesting in 1977 may have been the result of extended time required for the initial pair-bond formation following the period of

inactivity of the nesting site. A similar delay in the Peregrine Falcon reproductive cycle was observed by the author in Mexico when the individual falcons failed to reactivate an old site were under continuous observation at two locations. As previously stated, dates for clutch formation and hatching were estimated by observing the behavior of the adults and the fledging dates were established by direct observation of the virgin flights of the young falcons. The Peregrines at the Palisades eyrie were remarkably consistent during the 1975 and 1976 breeding seasons and the commencement of nesting during the two years was in advance of the Mt. St. Helena site by approximately two months in 1977 and a little under three weeks in 1978 (Table 8). This latter difference in timing is not considered unusual for the species in regions where seasonal climatic shifts are not severe in contrast to the arctic tundra Peregrine population (Cade 1960).

From 1970 to 1978 the fledging success has been monitored at the two peregrine falcon eyries considered in this discussion. The results of these observations have been presented in Table 9 which show that a total of 14 young have fledged in five seasons at the Mt. St. Helena eyrie for a mean of 2.8 fledged, and 18 young fledged in seven seasons for a mean of 2.6 fledged at the Palisades eyrie (Table 9). In light of the wide-spread reproductive failure of the species elsewhere in North America (Hickey 1968, Enderson 1967, Herman, Kirven and Risebrough 1970, White 1975) the fledging success of the falcons at these sites must be considered exceptionally high and emphasises the need for preservation of the habitats considered in these studies.

The fate of fledglings at the Mt. St. Helena eyrie could not be determined in the absence of telemetry data, but some noteworthy observations were made during the course of the 1978 study. Early in the nesting season an

Table 8 The Chronology of the Peregrine Falcon Breeding Cycle in the Known Geothermal Resources Area.

Authority	Year	Egg Laying Hatching Fledging			Location
		Dates	Dates	Dates	
Wenzel and Gheen	1975	3/22-25	4/25-26	6/5-6	Palisades, Napa County, California
Hunt	1976	3/19-22	4/22-23	6/3	Palisades, Napa County, California
Kirven	1977	5/19-22	6/22-24	8/4-6	Mt. St. Helena, Sonoma County, California
Kirven	1978	4/7-10	5/12	6/25-26	Mt. St. Helena, Sonoma County, California

Table 9 Fledging Success of Peregrine Falcons Nesting in
the Known Geothermal Resources Area.

Authority	Year	Number Fledged	Location
Wenzel and Gheen	1970	2	Mt. St. Helena
" " "	1971	3	" " "
" " "	1972	3	" " "
Kirven	1977	3	" " "
"	1978	<u>3</u>	" " "
n :14			Mean: 2.8
Wenzel and Gheen	1970	3	Palisades
" " "	1971	2	"
" " "	1972	4	"
" " "	1975	2	"
Hunt	1976	2	"
"	1977	4	"
Harlow	1978	<u>1</u>	"
n :18			Mean: 2.6

immature male peregrine arrived at the eyrie and was apparently accepted by the pair of adults. On 18 April he perched on the eyrie cliff and moved to a nearby tree perch where he was joined by the adult female with no sign of aggression on her part. He appeared at the eyrie cliff on two other occasions (28 April and 11 May) without eliciting territorial defense behavior in the adults. The only conclusion the author can make regarding these unusual observations is that this immature falcon fledged from the same eyrie during the preceeding year and has either remained in the area ever since or was drawn back to his familiar place of origin.

The 1978 fledglings were seen in the vicinity of the eyrie for a period of two months. They were not observed foraging successfully but abortive attempts to catch white-throated swifts near the cliff were frequently observed as were food exchanges from the parents to their offspring. The author observed a single female fledgling at the eyrie cliff on 26 July and again on 20 August. On both occasions the falcon uttered begging calls and the remains of freshly killed Mourning Doves were found at the rim of the eyrie cliff, presumably brought in by one or both of the adults from the valley below. This represents an unusually long period of post fledging parental care when compared to Arctic Peregrines (Cade 1960).

Floral and Faunal Diversity in the Study Area

The heterogeneous nature of the terrain and vegetation in the study area undoubtedly contribute to the remarkable biotic diversity which is exemplified in the floral and vertebrate faunal species lists included in this report (Tables 10, 6, 11, 12, 13). With elements of at least seven biotic communities represented well within the foraging range of the falcons, an ample food supply for successful reproduction is assured as long as the habitat remains unaltered by man. Any removal or simplification of these

Table 10 Plant Species in the Peregrine Falcon Foraging
Habitat at Mount Saint Helena in 1978.

TREES

Aceraceae	<u>Acer macrophyllum</u>	Big-leaf Maple
Betulaceae	<u>Alnus rhombifolia</u>	White Alder
	<u>Corylus cornuta</u> var. <u>california</u>	Hazelnut
Cornaceae	<u>Cornus nuttallii</u>	Mountain Dogwood
Cupressaceae	<u>Cupressus macnabiana</u>	McNab Cypress
	<u>C. sargentii</u>	Sargent's Cypress
Ericaceae	<u>Arbutus menziesii</u>	Madrone
Fagaceae	<u>Lithocarpus densiflorus</u>	Tanbark Oak
	<u>Quercus agrifolia</u>	Coastal Live Oak
	<u>Q. chrysolepis</u>	Canyon Oak
	<u>Q. douglasii</u>	Blue Oak
	<u>Q. dumosa</u>	Scrub Oak
	<u>Q. garryana</u>	Garry Oak
	<u>Q. kelloggii</u>	California Black Oak
	<u>Q. lobata</u>	Valley Oak
Hippocastanaceae	<u>Aesculus californica</u>	California Buckeye
Lauraceae	<u>Umbellularia californica</u>	California Bay
Pinaceae	<u>Pinus attenuata</u>	Knobcone Pine
	<u>Pinus coulteri</u> (planted)	Coulter Pine
	<u>P. lambertiana</u>	Sugar Pine
	<u>P. ponderosa</u>	Ponderosa Pine
	<u>P. sabiniana</u>	Digger Pine
	<u>Pseudotsuga menziesii</u>	Douglas Fir
Salicaceae	<u>Salix lasiolepis</u>	Arroyo Willow
Taxaceae	<u>Torreya californica</u>	California Nutmeg
Taxodiaceae	<u>Sequoia sempervirens</u>	Redwood

Table 10 -- Continued/

SHRUBS		
Anacardiaceae	<u>Rhus diversiloba</u> <u>R. trilobata</u> var. <u>quinata</u>	Poison Oak
Aristolochiaceae	<u>Aristolochia californica</u>	Dutchman's Pipe
Calycanthaceae	<u>Calycanthus occidentalis</u>	Spice Bush
Caprifoliaceae	<u>Lonicera interrupta</u> <u>Sambucus mexicana</u> <u>Symphoricarpos rivularis</u>	Chaparral Honeysuckle Elderberry Snowberry
Compositae	<u>Baccharis pilularis</u> ssp. <u>con-</u> <u>sanguinea</u>	Coyote Bush
Ericaceae	<u>Arctostaphylos glandulosa</u> <u>A. manzanita</u> <u>A. stanfordiana</u> <u>Rhododendron occidentale</u>	Eastwood's Manzanita Parry Manzanita Stanford's Manzanita Western Azalea
Garryaceae	<u>Garrya fremontii</u>	Silk-tassel Bush
Fagaceae	<u>Quercus durata</u> <u>Q. wislizenii</u> var. <u>frutescens</u>	Leather Oak Shrubby Interior Live Oak
Hydrophyllaceae	<u>Eriodictyon californicum</u>	Yerba Santa
Leguminosae	<u>Cercis occidentalis</u> <u>Cytisus</u> sp. <u>Lupinus albifrons</u> <u>Lupinus</u> sp. <u>Lotus scoparius</u> <u>Pickeringia montana</u> <u>Psoralea macrostachys</u>	Red Bud Broom Bush Lupine Deer-brush Chaparral Pea
Papavaraceae	<u>Dendromecon rigida</u>	Bush Poppy
Polemoniaceae	<u>Leptodactylon pungens</u> ssp. <u>pulchriflorum</u>	Granite Gilia
Rhamnaceae	<u>Ceanothus cuneatus</u> <u>C. incanus</u> <u>C. integerrimus</u> <u>C. foliosus</u> <u>C. jepsonii</u>	Buckbrush Coast Whitethorn Deer Brush Wavy-leaf Ceanothus Jepson's Ceanothus

Table 10 -- Continued/

Shrubs: continued

Rhamnaceae	<u>Ceanothus parryi</u> <u>C. purpureus</u> <u>C. ramulosus</u> <u>C. velutinus</u> var. <u>hookeri</u> <u>Rhamnus californica</u>	Parry Ceanothus Hollyleaf Ceanothus Coast Ceanothus Tobacco Bush Coffee Berry
Rosaceae	<u>Adenostoma fasciculatum</u> <u>Cercocarpus betuloides</u> <u>Heteromeles arbutifolia</u> <u>Holodiscus discolor</u> <u>Rosa spithamea</u> <u>Rubus discolor</u> <u>Rubus leucodermis</u> <u>Rubus</u> sp.	Chamise Mountain Mahogany Toyon Creambush Ground Rose Himalaya Blackberry Native Raspberry Native Blackberry
Saxifragaceae	<u>Ribes quercetorum</u>	Oak Gooseberry
Scrophylariaceae	<u>Mimulus aurantiacus</u> <u>Penstemon corymbosus</u>	Sticky Monkey Flower Beard-tongue
HERBS		
Amaryllidaceae	<u>Allium</u> sp. <u>Brodiaea californica</u> var. <u>leptandra</u> <u>Brodiaea congesta</u> <u>Brodiaea</u> sp.	Wild Onion California Brodiaea
Araliaceae	<u>Aralia californica</u>	California Aralia
Boraginaceae	<u>Cryptantha hispidula</u> <u>Cynoglossum occidentale</u> <u>Plagiobothrys nothofulvus</u>	Napa Cryptantha Western Hound's Tongue Popcorn Flower
Caryophyllaceae	<u>Cerastium viscosum</u> <u>C. vulgatum</u> <u>Stellaria media</u>	Mouse-ear Chickweed Common Chickweed Chickweed
Compositae	<u>Achillea borealis</u> ssp. <u>californica</u> <u>Agoseris heterophylla</u> <u>Agoseris retrorsa</u> <u>Artemisia douglasiana</u> <u>Carduus ovinocephalus</u> <u>Centaurea melitensis</u> <u>Centaurea solstitialis</u>	Yarrow Annual Agoseris Mountain Dandelion Mugwort Italian Thistle Napa Thistle Yellow-star Thistle

Table 10 -- Continued/

Herbs: continued

Compositae	<u>Cirsium proteanum</u>	Red Thistle
	<u>Cirsium vulgare</u>	Bull Thistle
	<u>Eriophyllum lanatum</u>	Woolly Sunflower
	<u>Gnaphalium</u> spp.	Cudweed
	<u>Grindelia camporum</u>	Gum Plant
	<u>G. hirsutula</u>	Gum Plant
	<u>Hemizonia luzulifolia</u> ssp. <u>rudis</u>	Tar Weed
	<u>Lactuca servola</u>	Wild Lettuce
	<u>Senerio vulgaris</u>	Common Groundsel
	<u>Sonchus asper</u>	Sow Thistle
Convolvulaceae	<u>Wyethia glabra</u>	Mule Ears
	<u>Convolvulus occidentalis</u> var. <u>solanensis</u>	Chaparral Morning Glory
	<u>C. subacaulis</u>	
Crassulaceae	<u>Dudleya cymosa</u>	Spreading Dudleya
Cruciferae	<u>Brassica</u> sp.	Mustard
	<u>Dentaria californica</u> var. <u>cardiophylla</u>	California Milkwort
	<u>Nasturtium officinale</u>	Watercress
Euphorbiaceae	<u>Eremocarpus setigerus</u>	Turkey mullein
Geraniaceae	<u>Erodium botrys</u>	Long-beaked Filaree
	<u>E. cicutarium</u>	Red-stemmed Filaree
	<u>E. moschatum</u>	White-stemmed Filaree
	<u>E. obtusiplicatum</u>	Filaree
	<u>Geranium molle</u>	Geranium
Hydrophyllaceae	<u>Nemophila heterophylla</u>	Baby-white Eyes
	<u>Phacelia heterophylla</u> ssp. <u>virgata</u>	Virgate Phacelia
Hypericaceae	<u>Hypericum concinnum</u>	Gold Wire
Iridaceae	<u>Iris macrosiphon</u>	Wild Iris
Labiatae	<u>Marrubium vulgare</u>	Horehound
	<u>Melissa officinalis</u>	Lemon Balm
	<u>Mentha pulegium</u>	Pennyroyal
	<u>Monardella villosa</u>	Native Pennyroyal
	<u>M. viridis</u>	Green Monardella

Table 10 -- Continued/

Herbs: continued

Labiatae	<u>Salvia columbariae</u> <u>Scutellaria californica</u> <u>Stachys rigida</u> ssp. <u>rivularis</u>	Chia Scull-cap Hedge Nettle
Leguminosae	<u>Lathyrus</u> sp. <u>Lotus corniculatus</u> <u>Lotus humistratus</u> <u>Lotus subpinnatus</u> <u>Lupinus bicolor</u> <u>Lupinus latifolius</u> <u>Trifolium albobpurpureum</u> <u>T. bifidum</u> <u>T. dichotomum</u> <u>Vicia californica</u>	Short-podded Hosackia Chile Hosackia Lupine Broad-leaved Lupine Clover Pinole Clover Branched Indian Clover California Vetch
Liliaceae	<u>Chlorogalum pomeridianum</u> <u>Lilium rubescens</u> <u>Zigadenus fremontii</u>	Soap Plant Star Lily
Loniceraceae	<u>Lonicera hispidula</u> var. <u>vacillans</u>	Honeysuckle
Papavaraceae	<u>Eschscholzia californica</u>	California Poppy
Plantaginaceae	<u>Plantago lanceolata</u>	Plantain
Polemoniaceae	<u>Linanthus acicularis</u> <u>Navarretia squarrosa</u>	Bristly Linanthus Skunk Weed
Polygalaceae	<u>Polygala californica</u>	California Milkwort
Polygonaceae	<u>Erigonum latifolium</u> ssp. <u>nudum</u> <u>Erigonum vinineum</u> var. <u>caninum</u> <u>Polygonum</u> sp. <u>Rumex acetosella</u> <u>Rumex</u> sp.	Buckwheat Buckwheat Knotweed Sheep Sorrel Dock
Primulaceae	<u>Anagallis arvensis</u> <u>Dodecatheon hendersonii</u> <u>Trientalis latifolia</u>	Scarlet Pimpernel Shooting Star Star-flower
Ranunculaceae	<u>Clematis lasiantha</u> <u>Ranunculus occidentalis</u>	Clematis Western Buttercup
Rubiaceae	<u>Galium bolanderi</u> <u>G. nuttalli</u>	Bedstraw Climbing Bedstraw
Saxifragaceae	<u>Whipplea modesta</u>	Modesty

Table 10 -- Continued/

Herbs: continued

Scrophulariaceae	<u>Castilleja</u> sp.	Indian Paint Brush
	<u>Cordylanthus tenuis</u> ssp. <u>brunneus</u>	Bird's-beak
	<u>Pedicularis densiflorus</u>	Indian Warrior
	<u>Penstemon breviflorus</u>	Gaping Penstemon
	<u>Penstemon heterophyllus</u>	Beard-tongue
	<u>Penstemon lemmonii</u>	
	<u>Verbascum thapsus</u>	Mullein
Solanaceae	<u>Solanum</u> sp.	
Typhaceae	<u>Typha latifolia</u>	Cattail
Umbelliferae	<u>Foeniculum vulgare</u>	Fennel
	<u>Lomatium repostum</u>	Napa Lomatium
	<u>Torilis arvensis</u>	Hedge Parsley
	<u>T. nodosa</u>	Knotted Hedge Parsley
Vitaceae	<u>Vitis californica</u>	California Grape

GRASSES

Gramineae	<u>Aira caryophylla</u>	Annual Hairgrass
	<u>Avena barbata</u>	Wild Oat
	<u>Briya maxima</u>	Rattlesnake Grass
	<u>Briya minor</u>	Small Quaking Grass
	<u>Bromus carinatus</u>	California Brome
	<u>Bromus diandrus</u>	Ripgut
	<u>Bromus marginatus</u>	Mountain Brome
	<u>Bromus mollis</u>	Soft Chess
	<u>Bromus rubens</u>	
	<u>Bromus tectorum</u>	Western Cheatgrass
	<u>Cynosurus echinatus</u>	Dogtail
	<u>Cynodon dactylon</u>	Bermuda Grass
	<u>Elymus caput-medusae</u>	Medusa-bead
	<u>Elymus glaucus</u>	Perennial Wild Rye
	<u>Elymus triticoides</u>	Creeping Wild Rye
	<u>Festuca californica</u>	California Fescue
	<u>Festuca idahoensis</u>	Idaho Fescue
	<u>Festuca megalura</u>	Malpias Fescue
	<u>Gastridium ventricosum</u>	Nitgrass
	<u>Hordeum jubatum</u>	Squirreltail Grass
	<u>Lolium</u> sp.	European Rye
	<u>Phalaris</u> sp.	Canary Grass
	<u>Polypogon interruptus</u>	
	<u>Polypogon monspeliensis</u>	Rabbit's-foot Grass
	<u>Sitanium hystrix</u>	
	<u>Stipa lepidota</u>	

Table 10 -- Continued/

 FERNS, SEDGES & RUSHES
Ferns

Aspidaceae	<u>Athyrium filix-femina</u> var.	Lady Fern
	<u>californicum</u>	California Sword Fern
	<u>Polystichum californicum</u>	Western Sword Fern
	<u>Polystichum munitum</u>	
Blechnaceae	<u>Woodwardia fimbriata</u>	Western Chain Fern
Polypodiaceae	<u>Polypodium californicum</u>	California Polypody
Pteridaceae	<u>Adiantum jordanii</u>	California Maidenhair
	<u>Onychium densum</u>	Cliff-brake
	<u>Pellaea andromedaefolia</u>	Coffee Fern
	<u>Pellaea mucronata</u>	Bird's Foot Fern
	<u>Pityrogramma triangularis</u>	Gold-back Fern
	<u>Pteridium aquilinum</u> var. <u>lanuginosum</u>	Bracken Fern

Sedges

Equisetaceae	<u>Equisetum</u> sp.	Horsetail
Juncaceae	<u>Juncus balticus</u>	Baltic Rush
	<u>Juncus bufonius</u>	
	<u>Juncus effusus</u>	
	<u>Juncus ensifolius</u>	
	<u>Juncus patens</u>	

Table 11 Mammals in the Study Area

Vagrant Shrew	<u>Sorex vagrans</u>
Trowbridge Shrew	<u>S. trowbridgii</u>
Broadfooted Mole	<u>Scapanus latimanus</u>
Little Brown Myotis	<u>Myotis lucifugus</u>
Yuma Myotis	<u>M. yumanensis</u>
Long-eared Myotis	<u>M. evotis</u>
Long-legged Myotis	<u>M. volans</u>
California Myotis	<u>M. californicus</u>
Silverhaired Bat	<u>Lasiomyotis noctivagans</u>
Red Bat	<u>Lasiurus borealis</u>
Hoary Bat	<u>L. cinereus</u>
Pallid Bat	<u>Antrozous pallidus</u>
Brazilian Free-tailed Bat	<u>Tadarida brasiliensis</u>
Brush Rabbit	<u>Sylvilagus bachmani</u>
Blacktailed Jackrabbit	<u>Lepus californicus</u>
Sonoma Chipmunk	<u>Eutamias sonomae</u>
California Ground Squirrel	<u>Spermophilus beecheyi</u>
Western Gray Squirrel	<u>Sciurus griseus</u>
Douglas Squirrel	<u>Tamiasciurus douglasii</u>
Pocket Gopher	<u>Thomomys bottae</u>
Heermann's Kangaroo Rat	<u>Dipodomys heermanni</u>
Western Harvest Mouse	<u>Reithrodontomys megalotis</u>
Deer Mouse	<u>Peromyscus maniculatus</u>

Table 11 -- Continued/

Pinyon Mouse	<u>Peromyscus truei</u>
Duskyfooted Woodrat	<u>Neotoma fuscipes</u>
California Vole	<u>Microtus californicus</u>
Coyote	<u>Canis latrans</u>
Gray Fox	<u>Urocyon cinereoargenteus</u>
Black Bear	<u>Ursus americanus</u>
Ringtail	<u>Bassariscus astutus</u>
Raccoon	<u>Procyon lotor</u>
Longtailed Weasel	<u>Mustela frenata</u>
Badger	<u>Taxidea taxus</u>
Spotted Skunk	<u>Spilogale putorius</u>
Striped Skunk	<u>Mephitis mephitis</u>
Puma	<u>Felis concolor</u>
Bobcat	<u>Lynx rufus</u>
Mule Deer	<u>Odocoileus hemionus</u>

TOTAL SPECIES: 38

Table 12 Reptiles in the Study Area

Pacific Pond Turtle	<u>Chelonia marmorata</u>
Western Fence Lizard	<u>Sceloporus occidentalis</u>
Northern Alligator Lizard	<u>Gerrhonotus coeruleus</u>
Foothill Alligator Lizard	<u>G. multicarinatus</u>
Gilbert's Skink	<u>Eumeces gilberti</u>
Rubber Snake	<u>Charina bottae</u>
Racer	<u>Coluber constrictor</u>
Sharp-tailed snake	<u>Contia tenuis</u>
Western Ringneck Snake	<u>Diadophis amabilis</u>
California Mountain King Snake	<u>Lampropeltis zonata</u>
Common King Snake	<u>L. getulus</u>
Gopher snake	<u>Pituophis catenifer</u>
Western Garter Snake	<u>Thamnophis sp.</u>
Pacific Rattlesnake	<u>Crotalus viridis</u>
TOTAL SPECIES: 14	

Table 13 Amphibians in the Study Area

California Slender Salamander	<u>Batrachoseps attenuatus</u>
California Newt	<u>Taricha torosa</u>
Rough-skinned Newt	<u>T. granulosa</u>
Pacific Giant Salamander	<u>Dicamptodon ensatus</u>
Eschscholtz's Salamander	<u>Ensatina eschscholtzi</u>
Arboreal Salamander	<u>Aneides laevis</u>
Black Salamander	<u>A. flavipunctatus</u>
Western Toad	<u>Bufo boreas</u>
Pacific Tree Frog	<u>Hyla regilla</u>
Yellow-legged Frog	<u>Rana boylei</u>
Red-legged Frog	<u>Rana aurora</u>

TOTAL SPECIES: 11

communities as a result of extensive industrial, residential or agricultural development of the area would probably threaten the long-term survival of the species as it clearly has throughout Southern California, where Peregrine Falcons now appear to be virtually extinct as resident birds.

RECOMMENDATIONS

The results of this study and observations of the preceeding year indicate that endangered American Peregrine Falcons have successfully re-established a traditional nesting site at Mt. St. Helena and the habitat appears to be optimal at the present time, because maximum reproductive success was observed during the past two breeding seasons. Although the precise extent of the foraging range could not be determined through visual tracking methods there were indications that foraging efficiency was high and continued reproductive success is assured as long as the biotic diversity of the foraging habitat remains intact. However, extensive human alterations of the habitat could threaten the long-term survival of this endangered species as it clearly has in Southern California where breeding Peregrines are now on the brink of extinction. In order to make a thorough assessment of the dependency of these birds on foraging habitat in the Known Geothermal Resources Area, and the fate of fledgling offspring, radio-telemetry data is required. Therefore, the author emphatically recommends the immediate initiation of the Phase II field study to accomplish these objectives during the 1979 breeding season.

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REPORT
ON
A PRELIMINARY STUDY OF THE PEREGRINE FALCONS
IN THE PROPOSED GEOTHERMAL DEVELOPMENT AREA
SONOMA COUNTY, CALIFORNIA

Submitted to

REPUBLIC GEOTHERMAL, INC.
11823 E. SLAUSON AVE., SUITE 1
SANTA FE SPRINGS, CALIFORNIA

and

OTHER INTERESTED PARTIES

by

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ABSTRACT

In the summer of 1977, a field study was undertaken to monitor the foraging activities of a family of American Peregrine Falcons nesting in the vicinity of the Republic Geothermal-McMicking Leasehold, Sonoma County, California, in an effort to determine the relative importance of the Briggs Creek drainage habitat within the Leasehold. Observational data consisting of visual compass bearings and triangulations of flight patterns of the falcons, and nest site activities, were interpreted to suggest that approximately one-third of the foraging flights were in the direction of the Briggs Creek drainage. Transect bird population censuses taken by Leitner and Miller in the riparian habitat were compared to prey remains collected at the falcon eyrie and showed a 23 percent overlap. Firm conclusions on the relative importance of the Briggs Creek habitat to the falcons during the critical reproductive period could not be drawn because the data were not sufficiently comprehensive. The principal investigator, Dr. Monte Kirven, suggested that a more thorough study utilizing established techniques of radio-telemetry be initiated as soon as possible so that more definitive statements can be made about the importance of the Briggs Creek habitat and the potential impact of geothermal development to the survival of the Peregrine Falcons.

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INTRODUCTION

Statement of the Problem

The population decline of the Peregrine Falcon in North America has been well-documented during the past thirty years and the species is now considered in danger of extinction by the U.S. Department of Interior (1). In the eastern United States, where approximately 300 pairs of Peregrines once nested, the resident population has been virtually extinct for over a decade (2). The extinction process, which has been attributed to contamination of the food chain with DDT (3, 4, 5, 6, 7, and 8) and habitat encroachment by man, was repeated in the Rocky Mountains, where the breeding population is now reduced to a few sterile pairs (9, 10). In California almost all of approximately 100 historical nesting sites are currently unoccupied (11), but there is a remnant population in the northern part of the state at the time of this writing (12, 13, and 14). Indeed, from my own observations, and those of others, it can be concluded that one of the last strongholds of the species between the Canadian and Mexican borders currently exists in northern California, particularly in the proposed geothermal development areas of Sonoma, Napa, Lake and Mendocino counties. In these areas the population is still producing young, in contrast to the situation elsewhere. The question of imminent importance is: to what extent will such development affect the continued survival of the Peregrine Falcon?

Objectives

This study was undertaken as an effort to monitor the foraging activities of a family of endangered American Peregrine Falcons (Falco peregrinus

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anatum) nesting in the vicinity of the Briggs Creek drainage which is on the McMicking Leasehold of Republic Geothermal, Inc. in Sonoma County, California.

Descriptions and depictions of the exact location of the falcon nesting site have been omitted from this report for conservation purposes and are deemed superfluous to the objectives of the study. It was hoped that the results of this study, and the simultaneous estimates of population densities of potential Peregrine prey species made by Philip Leitner and his field assistant, Gregory Miller, on the McMicking Leasehold would provide sufficient data to allow for an assessment of the importance of the Briggs Creek habitat to the survival of the falcons; and to predict the possible impact of exploratory drilling and associated excavations proposed for three locations within the McMicking Leasehold by Republic Geothermal.

METHODS

The Study Area

The study area is characterized by rugged, mountainous terrain heavily forested with Douglas-fir (Pseudotsuga menziesii), Ponderosa Pine (Pinus ponderosa), Knob-cone Pine (P. attenuata), Black Oak (Quercus Kelloggii), Coast Live Oak (Q. agrifolia), Oregon Oak (Q. garryana), Madrone (Arbutus menziesii), California Bay (Umbellularia californica), California Buckeye (Aesculus californica), and a diversity of other trees, shrubs, grasses and herbaceous species. The mixed evergreen forest is inundated with elements of the chaparral community consisting of mixed stands of Chamise (Adenostoma fasciculatum), Manzanita (Arctostaphylos spp.), Buckthorn (Rhamnus crocea), Wild Lilac (Ceanothus spp.), Mountain Mahogany (Cercocarpus betuloides), and a variety of associated species. The high, dense vegetation and uneven terrain of the study area presented obstacles for visual observation of the falcons.

The Observation Program

The field work was initiated on 9 July 1977 and terminated on 7 September of the same year. During the period of 16 July to 21 August, continuous observations were made on the foraging activities of the falcons from selected vantage points in the vicinity of the nesting site by a minimum of two experienced full-time observers. Observers were relieved at various intervals and the team consisted of Bruce Haak, John Schmidt, Marilyn Felton, William Grummer and myself. The bulk of the observations were made by Haak and Schmidt. Timothy Bowles, who was assigned to conduct surveillance of the eyrie by David Harlow of the U.S. Department of Interior, Fish and Wildlife Service as a part of the Pacific Coast Peregrine Falcon Recovery Team Program, was

at the site from 1 June and also participated as a member of the observation team throughout the duration of the study.

The eyrie was observed from a distance of 250 meters, which will be referred to as observation post number one (OP 1), with the aid of a 1250 mm Celestron V lens equipped with a Pentaprism spotting scope converter at 50 and 100 powers. The adult falcons could be seen from this vantage point as they departed and returned from foraging flights, but, unfortunately, the distance was too great for positive identification of all prey items. The second observation post (OP 2) was a prominence 750 meters from the eyrie toward Briggs Creek. From this location the nesting site and the Briggs Creek area could be seen in opposite directions. The third post (OP 3), situated upslope from OP 1 and 550 meters from the nesting cliff, and one kilometer from OP 2, was chosen after other sites were attempted and found to be unsuitable for coordinated observations.

Each observer was equipped with a 5-watt Realistic walky-talky radio, a Brunton Pocket Transit, a U.S.G.S. topographical quadrangle, drafting instruments, a field notebook, binoculars, and a 20x Bushnell spotting scope. Constant radio contact was maintained among the observers and it was the duty of the observer at OP 1 to alert the other observers at OP 2 and OP 3 when the falcons launched from the nesting cliff. He would inform them of the flight path of the falcon(s) and everyone would attempt to plot the compass headings from each observation post. Simultaneous headings were plotted, whenever possible, to triangulate the precise map locations of the falcons in an effort to determine the foraging range and movement patterns.

Identification of Prey Species

Thorough identification of prey species could not be accomplished from any of the observation posts because of the great distances involved, so on 21 August, long after the young falcons had fledged, Bruce Haak and I (Monte Kirven) rappelled down the face of the nesting cliff to collect prey remains from the eyrie hole and along the base of the cliff. Kirven and Haak were assisted in the climb by Denzil Verardo and William Grummer, who provided equipment and indirect aid of belay. Later, John Schmidt and I identified the prey remains and compiled a list of species. Timothy Bowles prepared a summary of his observations on the foraging activities of the falcons as seen from OP 1 from 1 June to 17 July, which provided some quantitative data on prey items brought to the nest by the falcons.

RESULTS

The topography of the terrain in the immediate vicinity of the eyrie and the behavior of the falcons were such that the majority of foraging flights could not be visually tracked throughout their entire courses. In most cases, however, at least a portion of each flight could be observed, and a total of 71 directional bearings were plotted from observation posts 2 and 3 and 20 triangulations were recorded during the period of 16 July to 21 August. Thirteen (63 percent) of the triangulations were within one kilometer of the eyrie and five more (25 percent) were within a radius of 2.2 kilometers, two of which were over the Briggs Creek drainage. The two remaining sightings were at four and five kilometers distance from the eyrie over the proposed drilling sites in the McMicking Leasehold. One of the latter was reported by Miller, who observed an adult Peregrine Falcon fly over one of the potential prey species transects. He noted that the falcon was heading toward a burned over Douglas-fir (Pseudotsuga menziesii) stand where Acorn Woodpeckers (Malanerpes formicivorus) frequently flew over the barren ground to and from tall dead snags. A total of 11 (55 percent) of the triangulations and 24 (33 percent) of the directional bearings were in the general direction of the Briggs Creek area.

Prior to the initiation of the continuous observation period on 16 July, Bowles maintained a constant vigil at OP 1 and recorded the foraging flights of the adult falcons as they departed from the nesting cliff and returned with prey. A summary of his observations has been included in this report (Table 1). Of a total of 45 outbound flights observed, 13 (40 percent) were oriented toward the Briggs Creek drainage, and of 72

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return flights with prey, 25 (34.7 percent) were from the same direction (Tables 1 and 2).

Table 1

Peregrine Falcon foraging flights from
eyrie as seen from observation post number one.

DATE	TIME OUT	SEX	TOWARD BRIGGS CR.	TIME BACK	FROM BRIGGS CR.	PREY
6/1	—	♂	—	1620	x	Rodent ?
"	1750	"	x	1830	x	No ID
6/2	1251	"		1540	x	Small Bird
"	1653	"	x	—		No ID
6/3	0834	"		1057		Small Bird
"	1136	"		1259		Quail ?
6/4	1225	"	x	1500		Domestic Pigeon
6/5	1225	"		1512		No ID
6/7	0758	"		1630	x	No ID
6/10	—	"	—	1253		Flycatcher ?
6/11	—	"	—	1525	x	Dove
6/12	—	"	—	1255	x	Small Bird
"	1500	"	x	1700		No ID
6/13	1350	"		1445		Small Bird
6/14	1014	"		1050		No ID
"	1700	"		1817		"
6/15	0925	"		1016		"
6/16	1053	"		1117		"
"	1448	"		1620		Small Bird
6/17	1355	"		1530		No ID

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Table 1 continued

DATE	TIME OUT	SEX	TOWARD BRIGGS CR.	TIME BACK	FROM BRIGGS CR.	PRTY
6/19	0910	♂		0950	x	Dove
"	1050	"	x	—		—
6/20	—	"	—	0925	x	Small Bird
"	1204	"	x	1315		"
6/22	—	"	—	1815		No ID
6/23	—	"	—	1028	x	Dove
6/24	1213	"	x	1436		No ID
6/25	—	"	—	1258	x	Small Bird
6/26	1430	"		1436		Flycatcher ?
"	—	"	—	0615		No ID
6/27	—	"	—	0855		Dove ?
"	1044	♀		1044		Band-tailed Pigeon
6/29	—	♂	—	1307		Dove?
6/30	1352	"	x	1710	x	Large Bird
7/1	—	"	—	0725	x	"
"	0910	"	x	0940	x	Dove
"	1015	"	x	1145	x	Small Bird
7/2	0700	"		0719	x	"
"	—	"	—	0849		Dove
"	—	"	—	0946		Very Small Bird
"	1137	"		1415		Blackbird
7/3	1355	"		1443		Large Bird
"	—	"	—	1615	x	No ID
7/4	1230	"		1315		Blackbird ?

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Table 1 continued

DATE	TIME OUT	SEX	TOWARD BRIGGS CR.	TIME BACK	FROM BRIGGS CR.	PREY
7/4	—	♂	—	1410		Dove ?
"	—	"	—	1759		Band-tailed Pigeon
7/5	—	"	—	0800		No ID
7/6	0855	♀		1020		Dove ?
"	1357	♂	x	1608	x	Medium-sized Bird
7/7	—	"	—	1152		No ID
"	—	"	—	1501	x	No ID
"	—	"	—	1815		Small Bird
7/8	1136	"		1210	x	Dove
"	—	"	—	1308		Small Bird
"	—	"	—	1356		"
"	1415	"		1515		Dove
7/9	0752	♀	x	0826		Small Bird
"	1110	♂		1137		"
"	1147	"	x	1315		"
7/10	—	"	—	0950	x	"
"	1420	"	x	1543	x	Dove ?
7/11	0955	"	x	1042	x	"
"	1529	"	x	1700	x	"
"	1529	♀	x	1700	x	"
7/14	—	♂	—	1020		"
"	1103	"		1106		Domestic Pigeon
"	—	"	—	1251		Pigeon ?
"	1445	"		1537		No ID
"	1445	♀		1537		"

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Table 1 continued

DATE	TIME OUT	SEX	TOWARD BRIGGS CR.	TIME BACK	FROM BRIGGS CR.	PREY
7/15	0832	♂		0900		Band-tailed Pigeon
7/16	—	"	—	0850		Small Bird
7/17	—	"	—	0805	x	No ID
"	0954	"	x	1011		Band-tailed Pigeon
"	1230	♀		1252		No ID

Table 2

Paragrine Falcon foraging
flights toward the Briggs Creek drainage.

FLIGHTS OBSERVED	PERIOD	NUMBER OF OBSERVATIONS	PERCENT	OBSERVERS
outbound from eyrie	6/1 to 7/17	18 of 45	40.0	Bowles
incoming to eyrie	"	25 of 72	34.7	"
triangulated sightings	7/16 to 8/21	11 of 20	55.0	Kirven, Haak, Schmidt, Felton, Bowles
directional bearings				
from OP 2	"	6 of 28	21.4	Haak
from OP 3	"	18 of 44	40.9	Schmidt, Felton
TOTAL:		78 of 209	MEAN:	37.3%

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Table 3

Prey species of the Peregrine Falcons
identified from remains found at the eyrie.

NUMBER	SPECIES	MORE THAN ONE FOUND
1.	Mountain Quail (<u>Oreortyx pictus</u>)	
2.	Black-bellied Plover (<u>Squatarola squatarola</u>)	
3.	Dunlin (<u>Erolia alpina</u>)	
4.	Band-tailed Pigeon (<u>Columba fasciata</u>)	x
5.	Rock Dove (<u>C. livia</u>)	x
6.	Mourning Dove (<u>Zenaidura macroura</u>)	x
7.	White-throated Swift (<u>Aeronautes saxatalis</u>)	
8.	Common Flicker (<u>Colaptes auratus</u>)	
9.	Acorn Woodpecker (<u>Melanerpes formicivorus</u>)	
10.	Western Kingbird (<u>Tyrannus verticalis</u>)	
11.	Barn Swallow (<u>Hirundo rustica</u>)	
12.	Cliff Swallow (<u>Petrochelidon pyrrhonota</u>)	
13.	Stellar's Jay (<u>Cyanocitta stelleri</u>)	
14.	Scrub Jay (<u>Amphelocoma coerulescens</u>)	
15.	American Robin (<u>Turdus migratorius</u>)	x
16.	Starling (<u>Sturnus vulgaris</u>)	x
17.	Western Meadowlark (<u>Sturnella neglecta</u>)	
18.	Brewer's Blackbird (<u>Euphagus cyanocephalus</u>)	x
19.	Red-winged Blackbird (<u>Agelaius phoeniceus</u>)	x
20.	Black-headed Grosbeak (<u>Pheucticus melanocephalus</u>)	
21.	Townsend's Chipmunk (<u>Eutamias townsendii</u>)	
22.	Bat (Chiroptera, species unidentified)	

On numerous occasions the adult falcons were observed to attack other raptors, including Golden Eagles (Aquila chrysaetus), Cooper's Hawks (Accipiter cooperi), Red-tailed Hawks (Buteo jamaicensis), Great Horned Owls (Bubo virginianus), and Turkey Vultures (Cathartes aura). The attacks on Golden Eagles were aggressive and were observed to take place within a radius of two kilometers from the eyrie. Based on these observations the total area of the defended territory of the falcons was estimated to be approximately 12.5 square kilometers.

The food remains found at the eyrie indicated that a diversity of prey species was exploited by the adult falcons during the nesting period, with a total of 22 distinct categories of prey items (Table 3). Due to the nature of the prey remains, which consisted of miscellaneous feathers and bones, quantitative estimates of relative proportions of the various species preyed upon by the falcons could not be obtained, except for a general indication that certain species were represented by more than one individual among the remains. From the observations by Bowles of prey items brought to the eyrie (Table 1) the Columbiform species: Rock Dove or Domestic Pigeon (Columba livia), Band-tailed Pigeon (C. fasciata), and Mourning Dove (Zenaidura macroura) comprised approximately 30 percent of a total of 72 prey items, and, because of their relatively large size, must be considered an important resource in terms of total biomass.

The tabulated results of the field study by Leitner and Miller of the bird populations in the McWicking Leasehold have been included in this report for comparative purposes (Table 4).

Table 4

Bird species observed per mile of transect on the Republic Geothermal McMicking Ranch Geothermal Leasehold, Sonoma County, California. (Eight days observation per transect, 26 July - 19 August 1977). Numbers in parentheses refer to individuals observed in large flocks.

SPECIES OBSERVED	NUMBERS OF INDIVIDUALS OBSERVED		
	Mixed Evergreen Forest, Near Proposed Wellsite One	Mixed Evergreen Forest, Near Proposed Wellsite Two	Riparian Briggs Creek
Great blue heron	2		
Mountain quail		5	25
California quail	2	28	
Mourning dove	4	75	45
Marsh hawk			1
Cooper's Hawk	26	1	
Red-tailed hawk			3
American kestrel		3	1
Great-horned owl			1
Belted kingfisher			9
Hairy woodpecker		2	1
Downy woodpecker		1	1
Nuttall's woodpecker	6	3	6
Acorn woodpecker	34	139	83
Common flicker	10	6	4
Western kingbird		4	2
Ash-throated flycatcher	2	3	
Black phoebe			12
Western wood pewee		2	41
Stellar's jay	24	90	57
Scrub jay	6	4	
Common crow			5 (458)
House finch	2		1
Lesser goldfinch	16		9
Lark sparrow		1	
Chipping sparrow	4		
Dark-eyed junco		31	47
Rufous-crowned sparrow		2	4
Rufous-sided towhee	10		
Brown towhee		16	25
Black-headed grosbeak		7	
Lazuli bunting		5	1
Western tanager	2	2	5
Hutton's vireo		3	4
Black-throated gray warbler	2	1	
Hermit's warbler	2		
Wilson's warbler		2	2
Rock wren		1	
Bewick's wren	4	3	
House wren			1

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Table 4 continued

SPECIES OBSERVED	NUMBERS OF INDIVIDUALS OBSERVED		
	Mixed Evergreen Forest, Near Proposed Wellsite One	Mixed Evergreen Forest, Near Proposed Wellsite Two	Riparian Briggs Creek
Brown creeper	4	1	7
White-breasted nuthatch	8	15	5
Pygmy nuthatch	4		
Plain titmouse	2	26	17
Chestnut-backed chickadee		13	
Wrenctic	6		
Bushy	74	32	23
Ruby-crowned kinglet	4		3
American robin	56	10	61
Western bluebird	3	13	
TOTAL SPECIES	27	34	34
TOTAL INDIVIDUALS PER MILE	324	550	521

The chronology of the breeding cycle was established by the following observations: (1) Bowles saw the adult female apparently feeding young for the first time on 24 June, (2) Kirven first confirmed the presence of three downy young, estimated to be approximately 20 days old, in the nesting hole on 9 July, and (3) we all witnessed the fledging of the first young male on 4 August. By assuming an incubation period of approximately 32 days, as reported for captive Peregrines (15), and a fledging period of approximately 42 days, as observed at other nesting sites (16), probable dates for clutch formation and hatching were estimated (Table 5).

Table 5

The chronology of the
Peregrine Falcon breeding cycle in 1977.

PROBABLE DATE OF CLUTCH FORMATION	PROBABLE DATE OF HATCHING	FLEDGING DATES
21 May $\pm$ 2 days	23 June $\pm$ 2 days	4 - 6 August

The young falcons fledged on 4, 5, and 6 August and sometime during that period one of the young males disappeared. An intensive ground search by all members of the observation team failed to produce evidence of the fate of the fledgeling. On 8 August the remaining male and female fledgelings were observed flying around the nesting cliff together. They were often seen in mock aerial combat and receiving prey from the adults in the weeks that followed. The young were still in the vicinity of the eyrie when Bowles made his last visit on 7 September.

DISCUSSION

Most of the foraging flights of the falcons could not be visually tracked during the course of this study because of the obstacles of local terrain and cover, and the inherent difficulties imposed in coordinated observations between observers. However, of those flights which were observed, at least in part, some general tendencies emerged. The falcons were seen to fly to all points of the compass with a significant proportion of flights directed toward the Briggs Creek drainage as evidenced by 50 percent of the triangulations and 33 percent of the directional bearings. The foraging range was seen to extend out to at least five kilometers over Briggs Creek. Miller reported Domestic Pigeon roosts at 7.2 and 8 kilometers from the eyrie, and since the falcons frequently preyed on this species it is possible that they raided the roosts on occasion. Early observations by Bowles at observation post number one indicated a large percentage (35 - 40 percent) of those flights were also in the direction of the Briggs Creek area. Thus, there appeared to be a general trend in all categories of visual observations indicating that over one third (37 percent) of all flights were directed toward the Briggs Creek drainage, suggesting the possible importance of this area as foraging habitat.

The adult falcons vigorously defended the eyrie for a distance of up to two kilometers representing a circular area of approximately 12.5 kilometers. The area acts as a buffer zone around the nesting site, and when the falcons are in the process of attacking potential nest robbers they become extremely vocal and hyperactive. At such times, they are vulnerable to hunters and curious hikers who might be drawn to the eyrie by the commotion. For this reason, the defended territory must be considered vital to the survival of

the Peregrines and should receive maximum protection.

Comprehensive data on prey items could not be obtained, but from the early observations at OP 1 and the actual prey remains collected at the eyrie, it is evident that the falcons exploited a wide variety of bird species and at least two mammals with 22 species represented. Certain Columbiform and Passeriform birds were preyed upon more frequently than others, specifically pigeons, doves, swallows, starlings, robins and jays. By comparing the prey lists with the data from the transect bird population censuses conducted in the McMicking Leasehold by Leitner and Miller it can be seen that nine of 47 species (19 percent) which might be considered potential Peregrine prey (excluding the Great Blue Heron, Red-tailed Hawk and Great Horned Owl) observed along the combined transects were among the prey items of the falcons. Also, seven of 31 species (23 percent) seen in the Briggs Creek riparian habitat were preyed upon by the Peregrines.

Taking into consideration that more than one third of all flights observed during this study were in the direction of the Briggs Creek drainage and that a comparatively higher percentage of riparian prey species was exploited by the falcons the Briggs Creek habitat could be especially important as a foraging area. Radio-telemetry studies on the foraging activities of breeding Peregrines in the Rocky Mountains have revealed that flights were directed toward selected habitats and not randomly dispersed (9). In the absence of such data for the falcons considered in this study firm conclusions about habitat selection cannot be drawn. Consequently, it is the author's opinion that judgements of the relative importance of foraging habitat, which would affect the continued survival of the Peregrine Falcons in the study area, are impossible without radio-telemetry data. Therefore, it is recommended that such a study be undertaken as soon as possible by experienced falcon biologists.

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Abstract.

Two adults and two young peregrine falcons were radio-tagged to determine foraging behavior near an eyrie in the Geysers-Calistoga Known Geothermal Resource Area. Equipment failure prevented detailed analysis of movements, but tracking data coupled with data from observers near the eyrie permitted analysis of 139 flights by the female and 40 by the male. Flights were categorized as those less than 1 km from the eyrie, extending about 1 km but perhaps proceeding farther, and long flights beyond 1 km. All flights were assigned one of seven vectors, one of which was in the direction of the geothermal area. Long flights on that vector included 9 and 12% of all long flights for the female and male respectively. Long flights for the female were mainly southeast from the eyrie (36%) and for the male they were southwest (35%). The observer data alone in 1979 indicated that 11% and 15% of the flights of the female and male, respectively, were toward the geothermal area. Inbound flights by both sexes with prey from the geothermal area included 17% of all such flights. About 12% of flights made by both sexes observed in another study in 1978 were to or from the development area, and other 1977 results suggest that up to 33% were in that direction. The proposed development site is small and lies 6 km west of the eyrie. The relatively few flights in that direction, the non-selective use by the falcons of flight routes in most other directions, and the general high abundance of prey in the region indicate that development of the geothermal site would not result in significant loss of foraging resource to the peregrines.

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R. Olendorff of the Bureau of Land Management provided administrative direction for the study. The U. S. Fish and Wildlife Service maintained the observers whose field data have been useful. The California Department of Fish and Game approved the study and demonstrated interest in resolving issues relating to impacts on peregrines.

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INTRODUCTION

Historical Perspective

The Geysers - Calistoga Known Geothermal Resource Area includes the McMicking Leasehold of Republic Geothermal, Inc., a proposed geothermal development site in the Briggs Creek drainage centering 6 km west of a peregrine falcon (Falco peregrinus anatum) eyrie occupied in the years 1970-73 and 1977 to present. In 1977, M. Kirven and co-workers under contract to Republic Geothermal visually studied the movements of the adults to determine the importance of the development site to foraging peregrines (Kirven 1977). In May, 1978, a research advisory committee, representing the California Fish and Game, the U. S. Fish and Wildlife Service, the Bureau of Land Management, National Audubon Society and the Geothermal Resource Impact Projection Study (GRIPS), was appointed to guide further study. In 1978, visual tracking of the adult falcons was undertaken in a study by M. Kirven for GRIPS. Positions of foraging falcons and headings of hunting flights were obtained, but radio-telemetry studies were indicated because of the limitation of visual range.

The 1979 Study.

The present work sought to reveal the extent of foraging flights, correlate successful hunts with habitat type, and determine the importance of the development area in providing food resource for the peregrines. The movements of adults and young fitted with radio transmitters were to have been monitored throughout flights away from the eyrie by triangulation of bearing data simultaneously obtained by two tracking receivers. Equipment malfunction and breakage prevented completion of

these goals. Useful telemetry data on foraging regions were obtained for the adult falcons and permit an analysis of the relative importance of the Briggs Creek drainage to the birds. This report also includes an analysis of the visual data obtained in 1977 and 1978 in light of the present study and integrates 1979 observations by U.S. Fish and Wildlife Service observers stationed near the eyrie.

METHODS

Equipment

Telemetry receivers were AVM Instrument RB-4 single-channel instruments with three sub-channels. SM-1 transmitters weighing 15g were matched to the receivers in the 148.075 - 148.125 MHz range permitting distinction among six transmitters. Transmitters were fitted with batteries providing power for up to 90 days depending on requirements of each transmitter. Transmitters, coated with dental acrylic, were fitted with 38 cm guitar wire antennas 0.011 inches in diameter.

Tracking station antennas were four-element directional yagis mounted on three-meter rotating masts equipped with bearing discs at the bases. Co-axial cable 4m long linked antenna to receiver. Head phones reduced outside noise. CB transceivers powered by automotive batteries or mercury cells provided communications between tracking stations and the observer near the eyrie. Tracking stations were established on the summit of Mount Saint Helena (MSH) 2 km south of the eyrie, and on Chalk Point (CP) 4 km southwest because they maximized line-of-sight coverage of the region (Fig. 1).

Two separate tests established bearing error on a test transmitter

8 km from receiver. The error was $\pm 5^{\circ}$, but one 8° error was obtained. Maximum line-of-sight range exceeded 15 km, but intervening terrain interrupted transmission. Bearings of instrumented birds were taken at 30-second intervals when possible.

Trapping

Adults and young were trapped in the vicinity of the eyrie with nets or snares; they were then hooded, instrumented, and released immediately. The male was to be trapped in April, the female in late May, but the female was caught on 21 April and fitted with a transmitter sewn to a single tail feather. The male was elusive and not caught or instrumented in the manner of the female until 2 June. Both birds behaved normally upon release.

The young were not radio-tagged in the eyrie because of high risk of flushing them from the ledge prematurely. Four young began fledging on 11 June, but only three males were present when trapping began on 24 June. One was caught on 24 June; another was trapped on 25 June. Both were fitted with tail-mounted transmitters. The third young could not be caught because his perching and feeding areas became unpredictable.

Operations

Appendix I provides a summary of field operations from 17 March - 6 July. Prior to 21 April the nesting situation was checked, and equipment was readied. The female's transmitter operated from 21 April to 1 June when the antenna separated. In that period, useful telemetry data (usually without triangulation) was obtained on 14 days. Poor weather and transceiver malfunction

were major and recurring problems. Trapping operations sometimes pre-empted tracking.

The adult male provided only four days of tracking data, some of it involving triangulation, in the period 3-6 June. On the latter date the antenna separated from the transmitter.

The young male instrumented on 24 June provided tracking data on only one day; that transmitter lost useful strength by 3 July. The second young male was equipped with a transmitter on 25 June, but the pulse rate slowed almost immediately, became erratic, and failed within the day.

Interpretation of Telemetry Data

Telemetry information for the female consisted mainly of headings taken on MSH on 14 days in the period 21 April - 31 May. The female was incubating or brooding small young in that period and on only one day were simultaneous headings obtained at MSH and CP. The adult male ranged more widely, and triangulation data were obtained in three of the four days his transmitter operated. One young was tracked from MSH on 1 July, nearly three weeks after fledging.

The field data, consisting of bearings and corresponding times, notations by tracking station operators, and notes taken by the FWS observer near the eyrie were collated in the following way:

- 1) Bearings were drawn from the tracking station on an overlay of a USGS 7.5 min topographical map. The time the bearing was obtained was noted along the line (Appendix II).
- 2) Remarks written by the station operators or received from the eyrie observer by transceiver were written on the bearing overlays where they related to movement of the falcon.

- 3) The notes of the FWS observer were summarized in regard to falcon movements to and from the eyrie for the days when telemetry data were available.
- 4) The general route of flights made in one day were traced on overlays of the topographic map integrating telemetry bearings, triangulation data when available, notes taken by trackers, and the observers' notes (Appendix III). The resulting routes do not indicate the exact route of each flight, but only its general course based on signal direction, strength, flight courses seen by the FWS observer, and time intervals between sequential bearings. For example, a great shift in bearings 30 seconds apart coupled with a strong signal imply the bird was passing near the station. Sudden loss of signal implied the bird passed behind intervening terrain. Some segments of flights were uncertain; these were indicated by dashed lines.
- 5) Overlays of the generalized flight routes were then analyzed, flight by flight, in terms of the general regions through which the flight passed. These routes or vectors, are shown in Fig. 1 and are flight corridors normally used by the adults. Several vectors correspond to topographical features:
 - F1 - westward from eyrie over ridge into Briggs Creek drainage and the region of proposed geothermal development;
 - F2 - southwest on ridge toward the tracking station at Chalk Point and upper Knight's Valley;
 - F3 - southwest down canyon to lower Knight's Valley;
 - F4 - south from the eyrie toward the tracking station on Mount Saint Helena and southward;
 - F5 - southeast from eyrie on the east side of County Line Ridge

F6 - east from the eyrie toward St. Helena Creek drainage; and
 F7 - northeast from the eyrie, past Tom Dye Rock toward
 Collayomi Valley.

When a flight, or part of a flight on the general route overlays involved a vector, a mark was placed on the vector (Fig. 2). Marks on each vector in Fig. 2 and 3 represent three categories of flights:

- 1) Marks on vectors plotted near the eyrie, within the 1.0 km radius circle, represent flights in the corridor during which the falcon did not fly farther than 1.0 km from the eyrie.
- 2) Marks on vectors plotted at the 1.0 km circle represent flights that may or may not have exceeded about 1 km from the eyrie.
- 3) Marks near the far ends of the vectors represent flights known to have exceeded 1 km from the eyrie in the region of the vector, but the precise extent of the flight was not often determined.

Interpretation of Observer Information

1979. A FWS observer was stationed at a vantage point 350 m south of the eyrie on 52 days in the period 3 April - 19 June. This observer recorded the arrival, departure, and other behaviors of the falcons. This information was used with telemetry data to reconstruct generalized flight routes of the falcons. The observer data were also examined for patterns in the use of flight vectors and for vectors used during arrivals from successful hunts.

1978. From 30 May to 20 August two observers (one 350 m south, the other 760 m southwest of the eyrie) cooperated by radio to determine the flight bearing of adults when finally lost from view (Kirven 1978). The

report provides a map of 65 positions and the direction of flight for each. These data were plotted on the same vector system applied to the 1979 results.

1977. From 9 July to 7 September 1977 observers were stationed at vantage points in the vicinity of the eyrie to determine the direction of flights of the foraging adults (Kirven 1977). Whenever possible, positions of the birds were determined simultaneously by two observers and triangulated. These positions and the data on flight direction are analyzed in this report in terms of the seven flight vectors.

RESULTS

Telemetry Information Augmented by Observer Data

General. Figures 2 and 3 show the distribution of flights, or portions of flights, from the overlays of generalized routes. Marks within the 1 km radius represent round-trip flights and were often substantiated by notes made by the FWS observer stationed 300 m south of the eyrie. These flights, sometimes interrupted by perching, usually of short duration, included a few hunting flights and defense flights.

Marks plotted on the 1 km circle were known to approach 1 km from the eyrie, but may have gone farther because the beacon signal was lost or the falcon was lost from view. These flights, including round-trips and isolated departures and arrivals to the eyrie, are useful in that they suggest the regions where the falcons hunted.

Marks near the ends of the vectors represent round-trip flights, or portions of flights, judged to be in the area represented by the vector. When a flight passed more than one vector, a mark was placed on each vector involved; a single flight is represented by a mark on different vectors in

these cases. When a falcon returned to a vector left earlier in the same flight a second mark was entered. Marks for flights beyond 1 km do not reveal the precise distance from the eyrie or the time spent in the area of the vector.

Adult female. The beacon of the adult female provided useful information on her position for 14 days in the period 27 April - 31 May 1979 (Fig. 2). Flights less than 1 km from the eyrie centered on vectors F1 and F7, both including favored perches and loafing areas. Vector F5 passes an apparent perching area southeast of the eyrie, but often the female's position there was uncertain because a ridge blocked radio reception from Mount Saint Helena.

Long flights, over 1 km from the eyrie are of most interest, especially when they were toward the proposed development site on vector F1. Of 64 such flights recorded on Fig. 2, 6 (9%) were known to have crossed the ridge westward toward Briggs Creek and the development area. Some long flights on F2 may have turned northward to F1; long flights of both these vectors include 25% of all long flights. Long flights with southerly components on vectors F2, F3, F4, and F5 include about 90% of all long flights. Over one-third of all long flights were on vector F5 to the southeast.

Some flights of unknown distance probably exceeded 1 km from the eyrie. If these 41 flights are added to the 64 long flights, 105 flights result; 13 are on vector F1 and are about 12% of all such flights. Long flights and those of unknown distance on vector F5 amount to 35% of all these flights. The telemetry and observer data in Fig. 2 indicate the adult female flew mainly toward the south when she left the area within 1 km of the eyrie, and used the area of the proposed development uncommonly

in the period of observation.

Adult male. The beacon of the adult male provide useful information in the period 3-6 June 1979 (Fig. 3). Long flights on F1 included 12% of all long flights. Flights known not to have exceeded 1 km from the eyrie include two westward along the ridge on F1 and one to a perching area northeast of the eyrie on F7, together comprising 8% of all flights. Flights that may have exceeded 1 km are mainly on F1 (four flights) and on F7 (five flights). These amount to 23% of all flights. Flights exceeding 1 km included all vectors, but 9 of 26 (35%) were on F2 southwest of the eyrie.

Some of the 11 flights of unknown distance probably exceeded 1 km from the eyrie. These added to 26 long flights total 37 flights; 7 (19%) are on vector F1 in the direction of the proposed development, and 9 (24%) of such flights were on the adjacent vector F2. The telemetry data supplemented by observer information in Fig. 3 indicate the male distributed his flights, in this brief period, more or less uniformly on most vectors, but known long flights predominate on F2 southwest of the eyrie.

Nineteen long flights by the adults were tracked beyond about 3 km from the eyrie (Table I). The locations of four of these flights were substantiated by telemetry triangulation; the others are inferred by signal strength and direction from CP or MSH tracking stations. Most of these flights were southwest, and some exceeded 7 km from the eyrie.

Flights by young. Only on 1 July was the young falcon with a functioning transmitter tracked out of the eyrie area. That male made three excursions to MSH: 1) down the ridge SW of the eyrie, south across the canyon to MSH, east to County Line Ridge and NW to the eyrie; 2) south from eyrie to the summit of MSH, probably south around the summit to the north side, circled NE of the summit, passed in view tracking station headed NW;

3) approached MSH from the NW, south and east around the summit, passed the tracking station and probably dropped northward under the summit toward the eyrie.

1979 Observer Data.

A variety of conditions precluded observation of all flights to and from the eyrie by the FWS observer, but 222 were recorded for the male (Fig. 4) and 215 for the female (Fig. 5) in the period 3 April - 19 June. The male showed surprisingly uniform use of all vectors within the visual range of the observer, except that flights on vector F7 to a perching hunting area to the northeast predominated. Flights on F1 in the direction of the proposed geothermal development account for 15% of all flights. Some flights on F2 may have been in that area; F1 and F2 flights collectively include 31% of all flights seen by the observer. The female (Fig. 5) also showed uniform distribution of flights by vector, except she favored F5 to a perching area. Only 11% of her flights were on F1 and 23% were on F1 and F2.

In 92 instances the observer recorded inbound flights by adults with prey (Fig. 6). These flights suggest the regions of hunting success because adults carrying prey probably return directly to the eyrie from the site of the kill. The male was seen inbound 72 times, especially from the northeast and south to west. The female brought in prey mainly from the south to west. Sexes combined, 17% of inbound flights with prey were on F1, and 40% on F1 and F2.

Analysis of the 1978 Observer Data.

The report (Kirven 1978) includes a map of 65 positions and direction of flight when the adults were lost from view. These data can be plotted on the vectors used in 1979 (Fig. 7). Sometimes positions were midway between vectors and in these cases a vector was assigned if the direction of flight was toward the vector. Most importantly, falcons flying on the ridge southwest of the eyrie were assigned vector F1 if their flight direction was toward the development area. The plots in Figure 6 do not distinguish flight distance from the eyrie since many were lost from view while in progress. About 12% of the flights are on F1 and 37% are on F1 and F2 combined. In 1978 the great majority of the flights had a southerly component.

Analysis of the 1977 Observer Data.

Positions of flying adults were determined simultaneously by two observers and triangulated. Directional bearings were recorded for the birds when lost from view. Terrain limited visibility such that 13 of 20 triangulations were within 1 km of the eyrie, 5 were within 2.2 km, and 2 were 4-5 km from the eyrie. Four of the triangulations beyond 1 km were in the direction of the proposed development. About 55% of all triangulations were in the general direction of the development (Kirven 1977).

In 1977, 71 directional bearings were recorded for the adults as they were lost from view. Of these 24, or 33%, were in the general direction of the development area.

DISCUSSION

Flights to the Briggs Creek Drainage and Development Area.

Flights on vector F1, some of those on F2, and perhaps a few involving other vectors may proceed into the Briggs Creek drainage (Fig. 1). The area of the proposed development site is small relative to the drainage; flights to the drainage do not necessarily include the development area.

Not all flights on F1 and F2 extended beyond 1 km from the eyrie in 1979. Of 55 flights determined by telemetry and augmented by observer data, 14 or 25%, did not exceed 1 km.

Table II summarizes the distribution of flights by vector determined by different means 1977-79. Flights on F1 in 1978 and 1979 include less than 20% of all flights. When flights on F1 and F2 are combined, up to 40% of all flights are included, a result not unexpected because F2 is along a ridge providing access to regions west and south. The 1977 data for F1 and F2 include those listed as "towards Briggs Creek" or "from Briggs Creek" (Kirven 1977). About half of the 1977 flights were in this group, a result probably biased upwards by the position of one observer 760 m from the eyrie on F1. Flights on other vectors were less well observed.

The Bureau of Land Management administers about 10.4 km² of land extending from about 3 km northwest of the eyrie to about 6 km north of the eyrie (Fig. 1). More extensive BLM lands lie northwest of this tract. BLM land would be encountered along about one-third of all bearings between north and west of the eyrie. Flights on F1 and possibly a few on F2 are within that sector. On that basis, a very rough prediction of use of BLM land by peregrines can be made. If less than 20% of all flights are on F1 (Table II) and 25% of these are less than 1 km from the eyrie, only 15% of all flights could reach BLM land. If these flights extended to 3 km, only about 5% would reach BLM land if no

preference for direction of flight within the northwest sector were shown.

Flights to Other Areas.

The pattern of flights by the adults at this eyrie in the breeding season is spread more or less eveningly among those available. Some vectors, taken together include obvious corridors to hunting areas. Vectors F2, F3, and F4 comprise the northwest slope of Mount Saint Helena, Rattlesnake Canyon, and Knight's Valley to the southwest. Between one-third and one-half of all flights were on these vectors, depending on the year and type of study (Table II.) Similarly flights on F5, F6, and F7 to the east include the vast Collayomi Valley and the east slope of Mount Saint Helena. Between about one-third and one-half of all flights were on these vectors.

The uniformity of distribution of flights, many of which are foraging flights, may be due to the obvious abundance of prey in the region. Bird count transects were made in 1977 by G. Miller and P. Leitner in the McMicking Leasehold (Kirven 1977). They found 324, 550, and 521 birds per mile of transect in two mixed forests and a riparian habitat, respectively. For comparison, averages of 84, 148, and 160 birds were seen per mile of transect in mixed forest, meadow, and riparian habitat, respectively, in Colorado. These represent the richest of 13 habitats sampled near six Rocky Mountain peregrine eyries (Enderson 1977).

Two other studies of radio-tagged breeding adult falcons allow comparisons of the patterns of flight distribution. A female peregrine tracked by triangulation from 7 June - 19 July 1977 distributed her foraging flights in many directions from the eyrie in Colorado (Enderson 1977). That peregrine appeared to favor mixed forest-brushland-meadow habitat and seemed to avoid pure stands of forest, sometimes ranging up to 19 km from the eyrie. Prairie falcons (Falco mexicanus) in Idaho, on the other hand, focused their foraging

flights in limited sectors of the potentially available habitat (Dunstan 1978). Perhaps this use limited to sectors resulted from competition with other adjacent pairs in that region of high prairie falcon density, and from the asymmetrical distribution of particularly good foraging habitat. In Colorado, as in the present study, suitable habitat was available in many directions.

It may be reasonable to generalize the results of the present study, and the other radio-tracking studies, to the foraging behavior of nesting peregrines elsewhere in the interior of California. The Mount St. Helena eyrie is located near the top of a divide between distant valleys. There are essentially no high barriers of terrain in almost every direction from the eyrie. In the 1977 Colorado study, the eyrie was on the highest point within 3 km. Both situations allowed foraging adults easy access in every direction. In both situations suitable prey was probably spread throughout the region around the eyrie. Under these conditions peregrines could be expected to distribute foraging flights in all directions. Conversely, where terrain much higher than the eyrie forms a nearby barrier or where prey abundance is strongly irregular as in the Idaho prairie falcon study, peregrines could be expected to show pronounced preference in the use of habitat for hunting.

Geothermal Powerplant Environmental Considerations.

The construction and operation of a geothermal powerplant on the McMicking Leasehold would increase noise, water vapor, hydrogen sulfide levels, and obstructions in the Briggs Creek drainage. Construction equipment can produce up to 95 dBA within 50 feet. Plant operation at full load can produce up to 93 dBA at the steam ejectors, but these high frequency sounds attenuate rapidly with distance. Given the intervening terrain between the

eyrie area and the development site, separated by a distance of 6 km, sound reaching the eyrie would almost certainly be nominal. Peregrines adjust to high noise levels. A nest ledge used for many years in the eastern United States was blackened by nearby steam locomotives, and two eyries active in the 1970's in the Rocky Mountains are within 1 km of coal-fired electric plants.

Increased water vapor content of the atmosphere increases fog likelihood within 2 km of geothermal plants. Fog may hamper peregrine foraging. Predictions of this effect are difficult, but since conditions favoring fog are projected at less than five percent on an annual basis, increase of fog in a significant area of the falcon foraging range seems unlikely.

The possible effects of increased hydrogen sulfide on the avifauna of the Briggs Creek drainage are unknown. Emission by new geothermal power plants are expected to conform to the California ambient air quality standard of 30 parts per billion. The eyrie is 2600 feet higher than the geothermal site, a differential reducing the possible effects of much higher concentrations during temperature inversions.

Power transmission lines are a hazard to peregrines because their attack dives may exceed 150 mph. Collisions with wires are well-known; at least six occurred in California in recent years (Kirven pers. comm.) and in 1978 in Colorado a young peregrine struck a power line 2 km from its eyrie and suffered a broken wing.

It is a mistake to assume peregrines are necessarily sensitive to or intolerant of all types of human activity within the eyrie foraging area. In Colorado, Enderson has studied 13 eyries used by peregrines in the 1970's. Nine were active at least one year in the period 1977-79 and of these 5 had highway traffic below the eyrie within 1 km, 2 had light traffic or pedestrians to within 0.5 km, and 2 were remote from disturbance. Of the four eyries not

active 1977-79, 1 was remote and 3 were often visited by pedestrians or rock-climbers; the latter are probably serious threats to nesting peregrines where the disturbance is continuous.

Management Recommendations

The following recommendations are based on the results of this study and on projections of impacts attending development on the McMicking Leasehold. The present study strongly implies that no significant loss of foraging habitat would result from geothermal power development confined to the leasehold, assuming that present prey abundances and the distribution of flights by the peregrines does not change importantly in the future.

1. The effect of development on prey and falcon use of the Briggs Creek drainage cannot presently be predicted. Careful records should be obtained each year (perhaps by a FWS observer) on flight distribution and the duration of foraging flights, to reveal changes in use of the drainage and apparent ease of obtaining food. Such data can be compared with the results of this and earlier studies.
2. Construction and operational activities associated with power development must not increase human presence within the area designated as Critical Habitat. Traffic on Ida Clayton Road is certain to increase during the construction phase. Access routes to the eyrie from that road should remain closed.

3. Power transmission lines should be routed only down the Briggs Creek drainage westward from the development site; none should be built in Rattlesnake Canyon or adjacent Knight's Valley. Future plans to build transmission lines within about 12 km of the eyrie should be reviewed on the basis of the flight distribution found in the present study.
4. The Fish and Wildlife Service should continue its observer program at this eyrie, extending the observation period to 1 March - 1 August. A major objective should be to discourage pedestrian and off-road vehicle access to the eyrie.
5. Affected agencies should secure land-owner cooperation or obtain ownership of properties within the designated Critical Habitat to assure no increase in habitat loss or disturbance.
6. The State of California and other affected agencies should develop a Nest Territory Plan for the eyrie as has been done for most Bald Eagle territories in California.

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TABLE I

Characteristics of Long Flights by Adults
Determined by Telemetry

<u>Date</u>	<u>Approximate Distance from eyrie</u>	<u>Area of flight</u>	<u>Triangulation evidence</u>
Female:			
1 May	> 3 km	SW of MSH ¹	-
2 May	> 3 km	SE of MSH	-
16 May	2.5 km	W of MSH	-
18 May	3 km	SW of MSH	-
23 May	7 km	Knight's Valley	-
	7 km	Knight's Valley	-
	> 3 km	Brigg's Creek	+
	> 3 km	Brigg's Creek	-
26 May	3 km	SW of MSH	-
	4 km	SE of MSH	-
28 May	3 km	SW of MSH	-
31 May	4 km	W of Fish Hatchery	-
Male:			
3 June	> 6 km	W of CP ²	-
4 June	> 7 km	W of CP	+
	5 km	S-SE of MSH	-
5 June	> 7 km	CP area	-
	> 4 km	Knight's Valley	-
	6 km	Knight's Valley	+
6 June	> 3 km	lower Rattlesnake Cyn.	+

¹MSH = Mount Saint Helena, see Fig. 1.

²CP = Chalk Point, see Fig. 1.

TABLE II

Distribution of Adult Peregrine Flights by Vector

Type of Data	Vector (% of all flights)						
	F1	F2	F3	F4	F5	F6	F7
1979:							
Telemetry and observers ¹ (n = 179)	19	12	11	11	26	5	16
Observers ² (n = 437)	13	14	16	12	16	10	19
Observers - Flights with prey ³ (n = 92)	17	23	14	16	9	3	18
1978:							
Observers ⁴ (n = 65)	12	25	14	15	19	9	6
1977:							
Observers - Visual triangulation ⁵ (n = 20)	(55) ⁷	-	-	-	-	-	-
Observers - Directional bearings ⁶ (n = 74)	(46) ⁷	-	-	-	-	-	-

¹ calculated from Fig. 2 and 3² calculated from Fig. 4 and 5³ calculated from Fig. 6⁴ calculated from Fig. 7⁵ from Kirven (1977)⁶ from Table I, Kirven (1977)⁷ includes flights "toward or from Briggs Creek"

FIGURE 1 Study Area and Flight Vectors

FIGURE 2 Distribution of Flights by the Adult Female
27 April - 31 May 1979

FIGURE 3 Distribution of Flights by the Adult Male

3 - 6 June 1979

Δ CP

FIGURE 4 Distribution of Flights by Adult Male Seen from Observation Station
3 April - 19 June 1979

FIGURE 5 Distribution of Flights of Adult Female Seen from Observation Station
3 April - 19 June 1979

FIGURE 6 Distribution of Inbound Flights with Prey Seen from Observer Station
3 April - 19 June 1979

FIGURE 7 Distribution of Flights of Adults Seen from Observer Stations
30 May - 10 July 1978

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FIELD WORK SUMMARY

PEREGRINE FORAGING STUDY - 1979

Abbreviations: MK - M. Kirven; JE - J. Enderson; PA - P. Anderson;
BB - B. Braker

17 March MK, D. Harlow, et. al. 1530 - 1624 hrs.
male soliciting, female copulation

24 March MK, S. Boyce 1700 - 1830 hrs.
male with kill from SE, food exchange, cache
female tending scrape, no incubation

1-April MK 1650 - 1720 hrs.
female incubating; food exchange

4 April MK
Kirven arranged cabin rental on Mt. St. Helena (MSH) with
D. Sands.

12 April MK, B. Grummer, J. Monk 0800 - 0820 hrs.
female flew from eyrie; took B. Bainbridge to
guard station.

18 April JE
JE dep COS arr Kirven's 0130 hrs, 19 April

19 April JE, MK, BB, PA
AM - equipment check, met with B. Olendorff
PM - Checked Sands cabin, visit Mt. St. Helena telemetry
station, obtained keys to gates, secured live owl.

20 April JE, MK, BB, PA 0900 - 2030 hrs.
AM - telemetry trials, MSH
PM - trapping attempts in canyon below eyrie;
falcons incubating; transceiver repairs.

21 April JE, MK, PA 0930 - 2030 hrs.
AM - trapping attempts with bait west of eyrie
PM - trapping attempts with owl
1550 hrs. - caught female; placed transmitter on tail feather
male incubating

22 April JE, MK, PA
JE - dep Oakland 1355 hrs
MK, PA - purchase miscellaneous equipment

23 April MK, PA 0840 - 1715 hrs.
0840 - set up tracking station MSH
1240 - lock for gate; returned key
1530 - went to eyrie to contact guard
1630 - went to Forestry office to check access to 2nd tracking
station.

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- 24 April PA, BB 1330 - 1805 hrs.
Looked for site for second tracking station
Charged transceiver batteries; signal from female
near Chalk Point (CP).
- 25 April MK, PA, BB 0700 - 1830 hrs.
0740 - checked access to Pine Mountain for tracking
station (TS)
0900 - checked CP and obtained permission to use it as TS.
1400 - checked equipment on MSH - all three receivers
checked okay.
female at eyrie
1730 - set up equipment at CP
- 26 April PA, BB 0610 - 1258 hrs.
0650 - PA at CP - no signal, no contact with MSH or guard
0813 - BB set up on MSH, female in eyrie
1250 - heavy rain all morning, female did not leave eyrie.
- 27 April PA, BB 0821 - 1614 hrs.
1020 - 1401 BB at MSH
0925 - 1614 PA at CP
no triangulation data, signals not obtained from CP;
female in or near the eyrie throughout period received
station, and guard, transceiver communications poor.
- 28 April PA, BB 0900 - 1945 hrs.
AM - transceivers to repair shops
PM - transceiver test at MSH and CP, checked okay, no tracking
- 29 April PA, BB 0605 - 1645 hrs.
0730 - 1135; 1356 - 1645 BB at MSH
0605 - 1645 PA at CP
transceiver battery failure, corrected at 1356,
no triangulation data, weak signals from female at
eyrie from CP.
female in or near eyrie throughout period.
- 30 April PA, MK 1030 - 1900 hrs.
entire day spent working on transceivers, purchasing
crystals, parts, meters, recharging batteries.
- 1 May PA, BB 0530 - 1850 hrs.
0622 - 1850 PA at CP
0751 - 1850 BB at MSH
signals from female 1713 - 1834 in rainy weather; no
signals received at CP; female was in or near eyrie
in period except for one flight to the west and two
flights east of County Line Ridge (CLR).

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- 2 May PA, BB 1125 - 1311 hrs.
1125 - ? PA at MSH
1030 - ? BB at CP
telemetry data after 1311 lost; no signal received
at CP, no notes from PA, BB: data after 1311 missing
female at or near eyrie, except for one flight SE over
CLR and east of MSH.
- 3 May PA, BB
Worked on battery packs and transceivers; no tracking.
- 4 May MK, PA 1000 - 1800 hrs.
1000 - 1130 MK went to guard post; female feeding
very small young.
1300 - 1800 PA, MK went to MSH, transceiver failed;
bought new transceiver.
- 5 May No field work.
- 6 May MK, BB 0700 - 1210 hrs.
0745 MK set up at CP, BB at MSH. No signal at CP, no
tracking data; no guard on duty, transceivers working
okay; MK spent PM checking guard whereabouts.
- 7 May MK 1030 - 1700 hrs.
MK at guard station, rain; female feeding small young
and brooding, male hunting, food-transfers.
JE dep. Colo. Springs 1530 - arr. Santa Rosa 2245.
- 8 May JE, MK, PA, BB 1000 - 1720 hrs.
Tested triangulation accuracy from CP and MSH with
transmitter + 3 mi. from CP. Signal 185° from CP,
no error; signal 228° from MSH, 8° error yielding an
error in position of 0.3 mi. Two new RB - 4s tested
okay on female from MSH.
- 9 May JE, MK, PA, BB 0730 - 1830 hrs.
Attempted to trap male with live owl on Fledging Rock
(FR), and on cliff after 1330. Male made shallow stoop
at owl early, but spent day perched on cliff or foraging;
female mainly brooding
- 10 May JE, PA, BB 0730 - 1800 hrs.
Attempted to trap male with dove and net from
1010 - 1800; first on FT and then under eyrie; male
tame, no response when dove in view; male hunting,
departing N and SE, and once NE towards Briggs Crk.

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- 11 May JE, MK, PA 0800 - 1900 hrs.
Obtained monofilament, 1125 set up net and live owl under
eyrie, male made stoop to within 50 ft. of it. 1440
placed noose carpet on male's perch in oak - he did not
return to perch. Immature female attacked by male.
- 12 May JE, MK, PA, BB 0700 - 2045 hrs.
0950 - JE put two noose carpets on branches in oak on
cliff, female did not use either perch entire day, brought
in five prey items.
- 13 May JE, MK, PA 1030 - 1630 hrs.
JE dep. for Colo. Springs
MK, PA obtained materials and set CP tracking antenna
in concrete; double check compass headings with landmarks.
- 14 May MK, PA 1100 - 1600 hrs.
Set up MSH antenna in concrete
- 15 May no field work, obtained motorbike for MSH
- 16 May PA, BB 0615 - 1800 hrs.
BB at MSH at 0715; PA set up at CP at 0740. B Grummer
at guard station.
female mainly in eyrie or on ridge from Goat Rock (GR)
to Tom Dye Rock (TDR). No signals at CP.
- 17 May PA, BB 0630 - 1800 hrs.
PA at MSH at 0700 - no radio contact with guard
(B. Bainbridge); BB at CP at 0930. Winds $\pm$ 70 mph on
MSH. Female mainly near eyrie and SE over CLR.
- 18 May MK, PA 0415 - 1730 hrs.
0700 - 1730 MK at CP; 0635 PA at MSH
No signals from CP, no guard; wind 50-60 mph MSH
Female mainly in eyrie, Twin Snags, and two flights SE
over CLR.
- 19 May MK, BB 0600 - 1300 hrs.
0650 - 1300 MK at CP; 0630 - 1300 BB at MSH
Female stayed in canyon throughout period.
- 20 May MK, BB, PA 0700 - 1830 hrs.
MK at CP 0700 - 0830; BB at MSH 0700 - 0800
MSH antenna found stolen, BB and PA spent day repairing
and replacing equipment; MK went to eyrie 1030 with
S. Boyce and new guard P. Crump.

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- 21 May JE, BB, MK, PA 0545 - 1430 hrs.
0635 - 1430 PA at MSH; 0720 - 1500 MK at CP
2330 JE arr. Santa Rosa with BB.
Female at eyrie through period in heavy fog.
- 22 May JE, PA, BB 1000 - 2045 hrs.
1205 JE set nooses on oak perch; female caught prey 1815;
no birds land in oak; leave nooses in oak.
- 23 May JE, MK, PA, BB 0400 - 1830 hrs.
0535 JE in blind, caught female at 0550; male and female
brought in 8 prey items through day. Took nooses down
at 1830.
0805 PA at CP; BB spent AM at MSH fixing blown fuse of
transceiver. In PM both stations obtained data; female
was SW of CP twice and NW in direction of Briggs Creek once.
- 24 May JE, PA, BB 0800 - 2115 hrs.
1330 JE placed nooses in Twin Snags perch after waiting
for male to leave area. About 1800 male lands on nooses
but not caught. Female made 2 kills, male at least 3.
- 25 May JE, MK, PA 0400 - 1830 hrs.
0520 JE, PA in hide under snags, male did not land there
all day. Female caught 2-3 prey, male 4-5 prey.
- 26 May JE, MK, BB 0800 - 1730 hrs.
JE dep. for Colo. Springs
0900 MK at CP, no signal all day.
0930 BB at MSH, returned to cabin since AVM supplied
wrong receiver cable, set up at 1200. Female active in
PM in Rattlesnake Canyon (RC) and once over CLR. No
triangulation data.
- 27 May MK, BB 0615 - 1700 hrs.
0730 - 1700 MK at CP; 0715 - 1700 at MSH, very windy
Female spent day near eyrie and near CLR.
Direction to test transmitter from MSH 215° - near perfect.
- 28 May MK, PA 0530 - 1800 hrs.
0605 - 1800 PA at MSH
0722 - 1800 MK at CP
no signals received at CP;
- 29 May PA, BB 0545 - 1900 hrs.
0955 - 1900 PA at MSH, too windy to set up earlier
1030 - 1830 BB at CP
Female spent all of the time near eyrie or E to SE.

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- 30 May PA, BB 0700 - 1700 hrs.
0810 - 1700 PA at CP too windy to track AM
0900 - 1830 BB at MSH
No signal from CP; female in area of
eyrie most of PM
- 31 May PA, BB, JE 0530 - 1910 hrs.
0610 - 1910 PA on MSH, high winds
0745 - 1900 BB at CP
transceivers inoperable
apparently 2 foraging flights to NW and 2 to SE
2335 JE arr. Santa Rosa.
- 1 June JE, MK, PA 0645 - 2115 hrs.
1110 - 2115 JE put 4 noose rigs on male's perches on
cliff; antenna not showing on female, signal
very weak; male landed on or near nooses 2-3
times - not caught.
- 2 June JE, MK, PA 0400 - 1830 hrs.
0700 JE re-arranged nooses on preferred ledge, male
kicked nooses off ledge at 0945.
1520 caught male.
- 3 June MK, PA, BB, JE 0630 - 2030 hrs.
0930 JE dep. Santa Rosa, arr. Colo Springs 2100
0730 - 1340 PA at CP; 1000 - 1300 BB at MSH
1535 - 1930 BB at CP.
1620 - 1915 PA at MSH
transceiver breaks down, no tracking communications
1240 - male flew far to W of CP; MK brought new transceiver
equipment, 2000 - 2030 meeting on equipment.
- 4 June MK, PA 0550 - 1900 hrs.
0550 - 1900 PA at MSH
0615 - 1700 MK at CP
fog until 1000 hrs., no movement of male until then.
Male made 2 flights SE; 2 N (spent 30 min. in
Briggs Creek area), and one down Napa Valley to south.
- 5 June MK, PA 0830 - 1850 hrs.
0900 - 1850 PA at MSH
1000 - 1700 MK at CP
Male made three flights to Briggs Crk. area,
two to Knight's Valley (one S and one W).
- 6 June PA, BB 0700 - 1725 hrs.
0730 - 1725 PA at MSH
1430 - 1700 BB at CP
Male made two flights north of eyrie ridge, one
east, and one SW (triangulation).

II
APPENDIX I

7

7 June MK, PA, BB 0530 - 1825 hrs.
0600 - 1825 PA at MSH wind 70-80 mph MSH
? - 1400 BB at CP
1400 - 1800 MK at CP
Winds too high until 1240; then no signals
(transmitter failed)

8 June MK, PA wind 70-80 mph MSH 0530 - 1630 hrs.
0600 MK set up test transmitter
0630 - 0700 MK at CP; 0800 MK at MSH: 1130 MK arr. eyrie
MK got no signal from male, antenna missing;
female gives weak signal

22 June JE - re-worked transmitters, nooses, equipment.

23 June JE - dep. Colo. Springs 0900 - arr. Kirven's 0315

24 June JE, MK, PA 0730 - 0730 hrs.
0830 arr eyrie, set 5 sets of nooses; 1645 caught one of 3
males

25 June JE, PA 0600 - 2000 hrs.
0710 - Set four noose sets; caught 2nd male at 0815

26 June JE, PA 0600 - 0830 hrs.
0800 - 5 noose sets ready; 1000 discover 2nd
transmitter not working; tried dead owl,
adult male stooped several times.

27 June JE dep. Santa Rosa 1000 - arr. Colo. Springs 1800.

28 June PA 1430 - 1630 hrs.
1536 - 1540 PA at MSH loud signal, remaining instrumented
young probably on CLR.

29 June PA
0930 - MSH; signal, young around TDR.

30 June PA MSH;
1630 - 1740 no signal;
1740 - 1745 good signal from TDR

1 July PA 1630 - 1759 hrs.
the tagged young flew south, and west of MSH;
seen with 2 other young three times, once at MSH station.

2 July PA 0749 - 0800 hrs.
the young is at eyrie, good signal.

II
APPENDIX I
8

3 July	PA weak signals from the eyrie area	0805 - 1005 hrs.
4 July	PA weak signals from the eyrie area	0836 - 0912 hrs.
5 July	PA Young male flew SW of MSH station and NE of station, both times at no great distance since transmitter is weak.	1509 - 1730 hrs.
6 July	PA No signal.	0615 - 0800 hrs.

II
APPENDIX II
1

APPENDIX II

PLOTTINGS OF TELEMETRY BEARINGS
FOR RADIO-TAGGED FALCONS

Shown are plottings by date of all bearings for the adult female (27 April-31 May), adult male (3 June-6 June) and one young male (29 June-1 July) made from overlays of the Mount St. Helena 7.5 minute quadrangle sheet. Bearings are shown as lines drawn in the direction of the signal from either of the two tracking stations. Numbers on bearing lines indicate time of observation.

Abbreviations: CLR - County Line Ridge
CP - Chalk Point Tracking Station
E - eyrie
GRR - Goat Roost Rock
IE - falcon in eyrie cavity
MSH - Mount St. Helena Tracking Station
NC - no signal received
TD - Tom Dye Rock
TS - Twin Snags perch 200 m west of eyrie

Scale: 1 inch = 0.75 km

29 April 0730-1015
1358-1631
0840 near sunrise (NE)

1356 IE
1358 IE

1 May ♀
0801-1834

1726

1724

1727

1728-1729

1730

1721
1750

1721

3043
E

0801, 0810
1751, 1834

1714

1713

APPENDIX II
3

1746-1747

1747-1748

1748-1749

1749-1750

1750-1751
1751-1752

4

2 May ♀

MSM

17 May ♀
1120-1800

18 May 7
0740-1452

⊕ CP

1417
1409
1401
1358-9
1347-48
1342

1338

0740-43

1452
1337
1007
0954
0922
5 ⊕ E
- left again to TS until 1418 → IE

over CLR?

0955
(0820)

II
APPENDIX II
7

had been over CLR

0830

MSH

0715

(0750)

751 753

0815

8.

10
0951

1223
1215
1210
(1154)

19 May 7
0700-1223

0945
⊕
W

⊕
MSH

⊕
CP

II
APPENDIX II
8

II
APPENDIX II
9

23 May 8
 MSH 1111-1751.5 Bch
 CP 1018-1737 Am

* = prey

pts must be in Rattlesnake Canyon

1428.5

1457

1429.5

1430
1428.5
1427.5
1703.5

CP ⊗

26 May ♀
1215-1708

1703

1702.5

1702.1

1701.5

1701
1701.5

1224, 1412, 1430.5

E ⊗ 1704-07

1423, 1437, 1708

1527.5

1527

1431
1571

1456

1429

1340-1345

II
APPENDIX II
II

27 May 9

⊕ CP

spent 1.5 hrs
up here

(1726)
1018.5
1541
(1588)
(1727)

1541.5

28 May ♀

0605-1727.5

(1342.5)

CP

after 1336

750

1017
1209
1212.5
1242.5
(1386)

1701.5-42
1244
1245.5
1540.3
1542.5

0103 - from 441 to 48
0741-48
(1023.5-26)
1213
1246.5
1543
1015.5

0856
(1026.5)
1208.5-04
1213.5
1215.48
1546-23.5
1547-9
1552-55

TS → 1231
then CE null
LK 1205
1214-5 (1132)

(58-51480)

0605-1580 2000-5090

17-6410
17001
→
Bifurca
1336

MSH

1044.5
1129

1227

(0901-04)
(0934)
(1005-104)
1027.5-1033
1127
(1128.5-1134)
1136.5
1137
1138.5
1140.5-1203
1219-44
1288
1505-25

II
APPENDIX II
13

1754

(1728)
(1731)
(1733-1740)
(1739-43)
1725-45

(1730)
(1731)

17545

29 May ♀
1307-1846

1753
587-1825
1600
1307-40-1846
6441
1307
⊕
EYRIE

apparently
or foraging flights
after 1600

APPENDIX II
II
14
I
E

c. 11:15 p

MSH

(1729)

⊕ CP

(1724)

1642.5

1613-20

1621
1642

suspect
lost antenna

1561-55391
1430 550 sig 355
1445 & parked in tree
1457 at 355 in tree

139A & merge (first transfer)
1395 & over CLR

1300 & to down snag - back to spine

1201-110
1622-9
1630
01/11-10/1
01/11-10/1
EYR/E

1629.5

30 May ♀

1200-1751

⊕ 1P

B MSH

II
APPENDIX II
15

II
APPENDIX II
15

3 June ♂

1543-46
1549.5-55

1240

CP = 1240 - 1556

1847.8

1205

1101.5

1108
1204.5

1030-1130
1-1/2 CLR
(33)

1105
1109.5

1204
1106
1108.5

1107.5-1134
1108.5

1102 1109
1103.5 1110
1105.5

1106.5
1135-1206

1103

1102.5

MSH = 1101.5 - 1915

APPENDIX II
17

II
APPENDIX II
19

0800-1804 PA
1614-1640.5 MK

into Briggs Lake
water level line
0401.5 serial 12 birds in region

(1640) 16491
(1640.5) 16491
1649.5-16491
coming in to
region PA

4 June ♂
(cont)

(cont)

Light House
June 16 Briggs Lake (PA)

II
APPENDIX II
20

4 June
MSH 09
CP

Coming in through
Briggs Co.

possibly
behind
hills

1635-1635.5
INTERMITTENT
SIGNALS

1636

9/91-10/96

4 June 9

1101-1403 NC

1510-12.5 ft
1531.5 - 6 ft
1547
11845-47 (in from W to prey)

1501
Toward TOR

1001

from behind circle

very likely
hybrid

APPENDIX II
21

June 6

5401

1841

1011 9301
1034 - 8060

1841
1609
1638
16091

EXR1E

1530.5

1403
1509
1637

1503.5

1001

1530.5
1531
1638

1643-1940 NC

1657-1642 signals indicator

1640

1530
1637.5
1639-40
(1641)

1641.5

1840.5
1843

1840

II
APPENDIX II
23

3-4 July 89 ♂

1403-1502 NC

1023-1034
flight in grid
1101-1105
inlet - again seen
1130 check rt side
1358 fine at saddle
(BRK - again)

1008-1012 NC

1025, 26, 27
(1401)
(1402)

1030
1007
1103
1104.5
1501.5
1508-9-1225
EYRIE
1358
1359
1508.5
1509.5

6 June ♂

(1505)

1503
1504.5
1505.5
1506.5
1507.5
1508.5
1509.5
1510.5
1511.5
1512.5
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1990.5
1991.5
1992.5
1993.5
1994.5
1995.5
1996.5
1997.5
1998.5
1999.5
2000.5

MSH

CP

1459
1458
1457
1456.5

1459

1458

1457

II
APPENDIX II
24

1615
(1626)
1710

1631
1633-34

1628-30

(1700)

1706

1632 1747
1707
0946
0951-1100

⊙ EYRIE

(1603-4)
(1625)
(1627)
(1648)
1701-2
1709 in sight
1746

0907-5

1620

1705

29 June 49 ♂

1614

1610
(1619)
1703

July 49 ♂

1609

1752-3

1750

1748
1751 164

1613
(1732)

under ds?

1611
1616

(1617)
(1618)

MSH

(1658)
(859)
(1631)
1740 1741
549 overhead
1754 overhead
1708

in sight

all 3 overhead

1754-58
overhead

(1658)
(1739)

1740

1741

APPENDIX III

PLOTTINGS OF ESTIMATED FLIGHT AREAS
OF RADIO-TAGGED PEREGRINES

Shown are generalized flight routes by date for the adult female (27 April-31 May), adult male (3 June-6 June) and one young male (1 July) made from overlays of the Mount St. Helena 7.5 minute quadrangle sheet. Routes incorporate data from tracking bearings (Appendix II) and observer sightings and indicate regions of flight. Numbers on routes indicate time of observation.

Abbreviations: CLR - County Line Ridge
CP - Chalk Point Tracking Station
E - eyrie
IE - falcon in eyrie cavity
MSH - Mount St. Helena Tracking Station
P - perched
TDR - Tom Dye Rock
— - strong signal
() - weak signal

Scale: 1 inch = 0.75 km

FISH HATCHERY

IE 1002

1119-1124

1135-1240 fX → F6

1401

1402 - F6

1605-1631

TDR

27 April ♀

() = weak signal

— = strong "

KELLOGG CREEK
RATTLESNAKE CANYON

MSH

CP

(c)

FISH HATCHERY

2 May, ♀

. CP

16 May ♀
• CP

0° 80°
TROUT HATCHERY

17 May 9
• LP

° °
FISH HATCHERY

° TDR

18 May ♀

• CP

19 May ♀

oCP

KELLOGG CREEK

MSH

CLR

TDR

SK

E

SK

120-23

120-23

II
APPENDIX III
9

II
APPENDIX III
10

26 May ♀

• CP

II
APPENDIX III
12

• CP

II
APPENDIX III
14

II
INDEX III
15

FISH HATCHERY

31 May ♀

CP

KELLOGG CREEK

TDR

E

MSA

II
APPENDIX III
16

(1322-2x)

(1324.5)

1130

1150.5

115

7.8

1135

0748

0749

0754

0756

0757

0758

0759

0800

0801

0802

0803

0804

0805

0806

0807

0808

0809

0810

0811

0812

0813

0814

0815

0816

0817

0818

0819

0820

(6912.5)

0751.5

0752.5

0753.5

0754.5

0755.5

0756.5

0757.5

0758.5

0759.5

0800.5

0801.5

0802.5

0803.5

0804.5

0805.5

0806.5

0807.5

0808.5

0809.5

0810.5

0811.5

0812.5

0813.5

0814.5

0815.5

(6912)

0751

0752

0753

0754

0755

0756

0757

0758

0759

0800

0801

0802

0803

0804

0805

0806

0807

0808

0809

0810

0811

(6912)

0751

0752

0753

0754

0755

0756

0757

0758

0759

0800

0801

0802

0803

0804

0805

0806

0807

0808

0809

0810

0811

II
APPENDIX III
18

ASH HATCHERY

II
APPENDIX III
19

II
APPENDIX III
20

FISH HATCHERY

II
APPENDIX III
21

*doubtful
(returned F3)*
(1515) probably read backangle

II
APPENDIX III
23

1 July 99 ♂

FINAL REPORT

Peregrine Falcon Foraging Study in the
Geysers - Calistoga Known Geothermal Resource Area,
Sonoma County, California - 1979

James H. Enderson
and
Monte N. Kirven

Submitted to

Bureau of Land Management
U. S. Department of the Interior

Contractor: James H. Enderson
Department of Biology
Colorado College
Colorado Springs, CO 80903
Contract No: YA - 512 - CT9 - 61